Science and Mathematics Education Centre

Towards a Culture-Sensitive Pedagogy of Physics Teacher Education in Mozambique

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature ……..

Date: ……. ……

DEDICATION

This thesis is dedicated to those who cannot express their views of the world in terms of World Modern Science and in this way become voiceless. It is also dedicated to those who are struggling to identify and express the different epistemologies, ontologies and axiologies that enrich our Mozambican cultural capital.

One of the hardest things teachers have to learn is that the sincerity of their intentions does not guarantee the purity of their practice. The cultural psychological and political complexities of learning and the ways in which power complicates all human relationships (including those between students and teachers) mean that teaching can never be innocent. (Brookfield, 1995, p. 1)

ACKNOWLEDGEMENTS

I am indebted to a number of people from whom I received assistance, both of a personal and professional nature, in order to carry out this study in Perth and Maputo, a study that reflects the support that I received from all of you. Thank you all.

My gratitude goes, first, to my parents: my mother who does not know how to read and write and my father who, when he was at home, used what was available to improve our skills in reading and writing, the newspaper. I recognise that the good qualities that I have are due to their influence.

I also pay tribute to my brothers and all my family, especially my wife Beatriz Josefa and daughters: Mariana, Ema (Beatriz), Helena, Veronica and Angela. I really appreciate the care that I receive from all of you.

While I was learning in the transformative study environment at Curtin University of Technology, the ever-helpful staff were a source of encouragement during my six years of full-time study, making my work challenging and also very enjoyable.

I had the privilege of having Associate Professor Dr Peter Charles Taylor as my mentor, supervisor and as well as my course coordinator in the four units that I did at SMEC (Science and Mathematics Education Centre). This experience, indeed, has provided me with a great opportunity to learn, not only about science education, but also about myself. For this, I would like to express my gratitude to Peter. The encouragement, assistance and guidance that I received from him have made me think about two fundamental questions: what is the meaning of teaching and am I teaching in the right way?

My study also provided an opportunity to develop my skills in the use of the English language. I have consolidated my abilities in my fourth language after Changana, Ronga and Portuguese. Thank you all who helped me to learn this unique way of expressing myself.

ABSTRACT

The problem that I have found while looking for better ways of teaching physics science is that the curriculum we Mozambicans are using 30 years after independence can be hardly distinguished from the colonial curriculum. I generated my research questions based on this problem.

I have adopted critical auto/ethnography and related trustworthiness criteria to respond to my research questions. I generated my data by looking from different perspectives at myself as learner, teacher and Mozambican citizen.

This research suggests that the actual situation of largely reproducing a colonial science curriculum can be overcome by the inclusion of a view of the world that I call *local-indigenous knowledge.* I have achieved three main outcomes from this research:

- The transformation that occurred to me – One of the main transformations was to my perception of my cultural identity. Using contemporary theories of culture and rationality I have explored and more fully realised my Mozambican cultural identity.
- The meaning of indigeneity and local indigenous knowledge. This research has allowed me to reconceptualise the meaning of indigeneity by exposing how it has been applied in a discriminatory sense and how it could be applied to promote the human dimension that exists in all human beings.
- A cultural model of teaching – I propose the use of both *local-indigenous knowledge* and *World Modern Science* to connect students to their history, their culture and their future. My cultural model of teaching encompasses four dimensions: (a) Use of local-indigenous language, (b) Learning by doing using locally available materials, (c) Use of stories to develop students' cultural awareness (identity) and (d) Inclusion of spirituality in science education.

These outcomes, which can be deepened and/or transformed by future studies, can be seen as distant from my initial research goal of learning techniques to 'deliver well' the curriculum content of my physics classroom; but, for me, these outcomes illustrate the emergent characteristic of this qualitative inquiry into the self-culture dialectic.

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Glossary

Agency – This term expresses the concept that a person has the freedom to create, change and influence events in his/her life.

Black – This is one of the expressions that show how imperfect human beings are. It was invented to discriminate a group of people or a race against other people or races. Hence the weakness is in its genesis. At that time races were believed to be defined by their geographical locations such as Africa, Europe, Asia, and the Americas. The term 'Black' has been used in an essentialist perspective in Mozambique especially during colonial time. I express this understanding by using a small 'b' (**black**)**.** In this perspective 'black' means 'others' who are not as human as the users of the term. The 'others' have a culture that should be destroyed and they should be assimilated into the culture of World Modern Science, for example.

I am still struggling with the meaning of the concept 'Black', with a capital 'B'. In this research I have used it in its discriminatory sense. However, I have no problem accepting, for example, how non-Blacks have identified themselves with Black people in Mozambique. I know that those Black by adoption can pack their bags and go whenever and wherever they want but many of them have contributed a great deal and have even died for my country, during the colonial era as well as other times. The strong emergence of Black people without black skin in Mozambique was during the liberation war (1964-1974) and the period after independence (1975). So, my perception is that for Mozambicans 'Black' means people who share the same experience of living in Mozambique. The term is losing, in this way, its discriminatory meaning. This is my non/essentialist understanding of the term 'Black'. I wonder how transferable my understanding of Black is within and outside of Mozambique.

Collateral learning theory is Aikenhead and Jegede's theory affirming that students can construct in the science classroom other concepts related to concepts existing in their local science, personal science and World Modern Science. There are three types of collateral learning: *Parallel collateral learning*

occurs when the new concept constructed in the science classroom never interacts with local or personal concepts. For example, students will define the concept of force in a World Modern Science way at school but this definition will never be used outside of school where commonsense about force prevails. In this instance students live in two independent worlds. *Dependent collateral learning* occurs when the new concept is contrasted with the old one. Three results are possible from this exercise: (a) rejection of the old concept; (b) rejection of the new concept; (c) combination of the old and new concepts. Dependent collateral learning can be seen as a process of enculturation, acculturation and assimilation (see the definition of these terms in this Glossary). *Secured collateral learning* occurs when learners use both systems of knowledge to solve the problems they are facing. They integrate the systems of knowledge. Occasionally, a fourth form of collateral learning, called *simultaneous collateral learning*, occurs. This refers to learning in one domain that facilitates the learning in another domain. An example of simultaneous collateral learning can be the case when students in the process of learning to set animal traps (which require elasticity in the material used) in a hunting activity better understand the concept of elasticity taught in the science classroom.

Collateral theory of learning describes the process of students crossing cultural borders into different worlds that places them in five categories:

(1) Potential Scientists - cross borders so efficiently and naturally that the borders seems not existing.

(2) Other Smart Kids – experience minor problems in the process of crossing borders.

(3) I Don't Know Students – the border crossing is troublesome.

(4) Outsiders – These are the students that apparently cannot express themselves using World Modern Science epistemology and ontology and hence their border crossing is virtually impossible.

(5) Inside Outsiders – Are those who are made voiceless by the school system and cannot cross borders because of their lack of participation in school science.

Coloured – This expression is hard to swallow as it shows the brutality of colonialism. Every people or race was attributed a Colour: White, Black and Yellow. But this group or race received the designation of 'Coloured'. In Mozambique 'Coloured' or Mulato means to be born of a mating of a Black and a White person. It seems that this designation intends to say that you are neither black/Black nor White, but something that was hard to determine for the colonizers. This term shows also the inefficiency of dualism. I am using 'Coloured' as the meaning given by the colonizer, with capital 'C', because it refers to people.

Democracy – It is hard to characterize democracy or democratic society and the education system that should exist there. An approximate image of democracy is an environment with compelling possibilities, strong responsibilities and inconsistent choices.

In Mozambique, we have had several kinds of democracy, according to official discourse, during the course of modern history: a democracy before independence when the country was run by colonial rule; a democracy immediately after independence when the country was run by Blacks (see the meaning in this Glossary); a democracy in a civil war when everything was justifiable as a way to bring peace; and now, a democracy in the current free-market environment.

All the democracies that we have had in Mozambique were aimed to 'allow' the participation of the people in the country's life. However, the desired participation did not occur, except perhaps immediately after independence. I do not know the causes for this poor participation, but I am confident that our education system, particularly science education, can foster that participation if it educates students through my proposed Cultural Model of Teaching (see Chapter Six).

Enculturation, Acculturation and Assimilation – I have elaborated in Chapter Five how to distinguish 'enculturation', 'acculturation' and 'assimilation'. However, throughout this thesis I do not adhere rigidly to those meanings.

I understand well that the literature distinguishes the concepts of ‘enculturation’, ‘acculturation’ and ‘assimilation’ from each other. Enculturation is defined as initiation in your own culture, Acculturation means learning things from another culture while remaining in your own culture. Assimilation implies moving to the new culture. Although this ontology is sound it does not accommodate my experience of learning and becoming a science teacher nor does it reflect my experience of being Mozambican.

In Mozambique, during the colonial era, we (Mozambicans) were literally forced to reject our culture and adopt colonial culture. The meaning of ‘acculturation’ and ‘assimilation’ in this colonial situation changed from ‘showing alternative ways of doing things’ and ‘adoption of new culture’ to an ‘imposition’ and ‘adoption’ of (or pretending to adopt) the new culture in order to enjoy the privileges attached to it.

I might characterise my teaching as me, a coloniser, colonising other Mozambicans because I am passing students who I have judged to be using the established norms and to have assimilated the laws and principles that I am teaching. I ask myself how this fits with ‘acculturation’, ‘assimilation’ and ‘enculturation’ described in the literature.

The views in the literature and my experience as colonized and teacher of ‘enculturation’, ‘acculturation’ and ‘assimilation’ have in common that the cultures existent in the world can be clearly distinguished as cultures A, B and C that have nothing in common. In other words, the individual in culture A is, necessarily, not in culture B or C.

The problem with this view is that culture (ways of living and interacting) are the skills that individuals have and not the individual per se. Furthermore, none of us has been able to fully grasp the complete culture of A, B or C. This fact leads me to question how acceptable is the concept of ownership in culture? I agree that there is the culture in which an individual is born and that that culture can influence the life of that individual for the rest of his/her life, but as the process of enculturation is without boundaries, perhaps it is unimportant to talk

about acculturation and assimilation as separate entities since, for me, these happen simultaneously, in a symbiotic way.

My image of cultures around the world is a circle (see Figure G.1 below) in which the individual is in the centre. The different cultures are in different locations. These are the locations where supposedly those cultures are, but simultaneously, they can be found in different points of the circle. How do then I see 'enculturation', 'acculturation' and 'assimilation' in this circle. 'Enculturation', 'acculturation' and 'assimilation' happen simultaneously and help the user of the culture(s), the knower, to live in more than one culture. The pretension of seeing boundaries among cultures is another manifestation of essentialism (see Chapter Four)

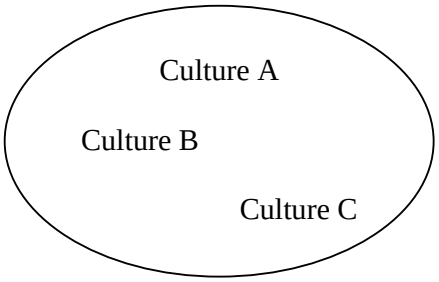

Figure G.1. Enculturation, Acculturation and Assimilation happen simultaneously.

Natives – Natives are people connected with the place where they: (a) were born and lived for the first years of their life (b) have lived for a long time. Although Portuguese people have been in Mozambique for five centuries, they were never considered natives. I am using this term to refer to people who identify themselves with Mozambique despite their colour and where they are geographically. In the context of the colonial period, 'natives' means *blacks*, but in the postcolonial period I am using the term to refer in an inclusive manner to all Mozambicans. The capital or small 'n' depends on the construction of the phrase. If the term creates confusion it is because the colonial context is not clear. Many Whites suffered as much as Blacks or even worse.

Opposites – Opposites are things or concepts that cannot be separated. They are connected in such a way that gives meaning to each other. Ex.: good/bad; heavy/light; love/hate.

White – It is amazing to see that the 'White' definition was never a preoccupation either before or after independence. During the colonial era, the meaning of 'White' was given by the physical presence of colonizers from Europe.

Hence, for me, this concept refers largely to Europeans. When colonizers came they were seen as ‘good’ because they brought clothes, wine and guns. The second meaning of ‘White’ is ‘good’. Even nowadays in Mozambique ‘good attitude’, such as helping an old person or a child on the bus or in the street is considered a White attitude. Hence, Black people helping others are seen as a White people with dark skin.

This phenomenon of seeing White with dark skin has been minimised by the physical disappearance of White colonizers. Nowadays, the contradiction of seeing a White person who is not white is interpreted as alienation. However, in the colonial era, to be White with black skin was promoted; blacks needed to be not black to avoid the pain attached to this condition. The regime established that to be non black, blacks should be ‘assimilado’ (assimilated). For Blacks this meant to be White. In this period (colonial era), Whites had the power of government and money; hence, the third meaning of White is ‘power’. Although not creating a great concern, people with money and power are called Whites by the ordinary people. I can not recall a situation where White meant a bad thing that could be expressed by **‘white’**. Do you wonder why? Likely this term was invented by Whites and maybe it was invented by the ‘White Jesus’ and the colour of peace that we still use in Mozambique. Are not those hegemonic ways of conveying the ‘good’ meaning of White? How could they attribute to themselves a derogatory meaning?

I am proud of being Black and I consider other human beings equal to me (all humility aside); hence, to refer to White people in this thesis I will use the word ‘White’. The second reason for using always ‘White’ is the recognition of my limitation in interpreting the struggles and anxieties experienced by White people during the colonial era. I am Black.

Chapter One: Introduction

Context of the Study

> If [Mozambicans] want to improve the quality of [education], a million workshops on methodology will not be enough. Good teaching does not come from technique. It comes from the identity and integrity of the teacher. If we want to teach well, we must learn more about the human dimensions of our craft about the inward sources of our teaching, about our relations with our students, about a teacher's wounds and powers (Palmer, 1997, p. 1)

Figure 1.1. Good teaching incorporates different views of the world.

Mozambique is situated on the south-eastern coast of the African continent bordered by the Indian Ocean and by Tanzania, Malawi, Zambia, Zimbabwe, South Africa and Swaziland. Mozambique was under Portuguese Colonial rule for 500 years. The main feature of this colonial system was assimilating Africans into Portuguese culture and making sure that the natives hated their own culture. This process occurred over a long period of time, and created a culture of 'contradiction'. Sometimes we pretend to be Europeans: using their language and attitudes, eating the same food and denying our cultural capital. At other times we behave like Africans: using our own language, habits and beliefs. One result of this long period of colonization is that each of us (Mozambicans) is a multicultural person who combines European and several African cultures.

Figure 1.2. African Map.

The majority of the population of Mozambique (19 million) live in the countryside. The major languages spoken are Portuguese (official), Makua-Lomwe, Tsonga, Shona and Swahili. Immediately after Independence, the country was involved in a bitter struggle against 'White' rule in Rhodesia and South Africa, until 1980. Overlapping these hostilities, in 1977, a horrible civil war started and resulted in a million Mozambicans dying from war and famine. Today a major legacy of this situation is landmines and amputees. The end of the civil war in 1992 was followed by eight years of stability and economic growth. After this period, the country was affected by several natural calamities, such as floods, drought and plague.

In Mozambique there is a cultural diversity that, as a science teacher educator, I believe should be addressed in education. For example, in Maputo province where I live, a strong influence on family life is hunting. In hunting, there are many concepts of World Modern Science involved, such as resistance of materials, elasticity and velocity. In Gaza there is an ethic group called *Chopi* which is well known for its traditional dance and the production of musical instruments. To the best of my knowledge, both dance and instruments are called *timbila*. In Gaza, again, according to my experience, there is a well-known oil called *Munhatsa* that is produced from the mafureira tree (see Figure 1.3). I am interested to know how I can incorporate this knowledge into my science teacher


Figure 1.3. Mafureira's fruit.

education classes; so that I can help to make my students proud of their Mozambican cultural heritage (identity). This constitutes one of my motivations to do this doctoral degree with the help of my mentor and supervisor Peter Taylor.

Figure 1.4. Peter.

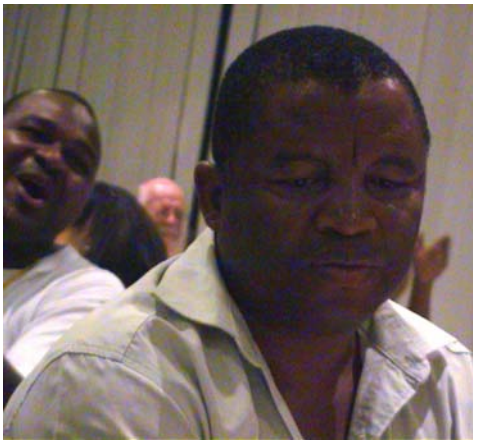
Figure 1.5. Cupane.

How to promote Mozambican culture?

Who is Doing this Research?

I am Mozambican, born in Gaza province in the 1960s. This means that transformations in my life have occurred and continue to occur in a transitional society. I am a Changana speaker (language included in the Tsonga language group). Through this research I delve into the transformations in my life and society. This self exploration is to answer questions about how science has been and how it could be taught in Mozambique. My purpose is to clarify for myself my position in Mozambican society, particularly my role as an educator of science teachers.

My first transitional period was my experience of moving from colonial to postcolonial times. This transition can be described by the history of my formal education. My first school was attended only by so-called black[1] students living in or near the suburb where the school was located. I do not remember even seeing Coloured people there. It was a private school that could not be distinguished from the majority of houses in the suburbs of Lourenco Marques (later named Maputo).

[1] See in the Glossary for how I distinguish between black and Black

In my first school, we had only one teacher for nearly 200 pupils, divided across years 1 (1ª classe) to 4 (4ª classe). The teacher used the older pupils from year 4 to help control the classes. In this school, mistakes were penalized with physical punishment. After one or two years in this school, I was moved, unexpectedly, by the colonial power to an official school.

My first school signified that I could have a life among my people. At that time I was not aware of 'black', White, and colonialism, and the struggle for freedom.

One day my mother took me to a crowded place where many Black children from poor schools like mine were accompanied by one of their relatives. We waited in front of an office called 'Urbanization'. This was my first time at this office, and I did not have any idea why we were there. The children were called by name. After waiting a long time my turn came. I was directed to sit in front of a White person (for the first time in my life) who was surrounded by Black people. I was around 10 years old. They opened a year 2 book and asked me to read. I remember that, although nervous, I read quite well. The book was probably the one that I was used to in my school. After reading two or three lines, they said I could stop. They gave me a paper to present to an official school called Paiva Manso.

Paiva Manso School, actually *Escola Primaria de Alto-Mae,* is located in the city area where my people and I rarely had access. The entire school was built of concrete with very thick walls. The school transmitted the image of solidity and durability. The school had electricity and running water and other facilities that we could hardly dream of. I remember that in a male toilet we had a very tall and massive man who made sure that we (Blacks) used the urinal correctly. At that time it seems to me that it was a natural procedure but looking back I see how hateful it was as he was focussing his attention according to the colour of our skin. I do not remember having any female friends so probably it was a school for boys.

My sister was chosen to go to another school in town called *General Machado*. In those first days we spent a lot of time describing to each other the roads that we were crossing and other challenges that we were facing on our way

to and from school. It took some time for us to discover that we were describing, in some cases, the same roads.

Today, I believe that the offer of a place in Paiva Manso School was made because of the pressure of the liberation war. The Portuguese administration felt the need to 'paint' their schools with so-called black people, to show that they were educating the 'natives'. For me, it was the beginning of my interaction in the same classroom with White and Coloured people.

After two years, in 1974, I finished year four (quarta classe). This was the end of primary education at that time. Simultaneously in that year, on the 7th of September, the colonial power and Mozambican Liberation Movement (Frente de Libertacao de Mocambique - FRELIMO) signed a peace agreement. This was the end of the liberation war and the beginning of the passing of power from the Portuguese to the Mozambicans. It was also the beginning of experiencing a second transition, from being a segregated person, in racial and tribal terms, to not being discriminated and being united inclusively with Whites around a common dream of building an independent country under a socialist/communist flag.

I went to secondary school under a transitional government composed of Mozambicans and Portuguese, with a Black man as our leader. At that time, secondary school education was organized on three levels, as shown in Table 1.1.

Table1.1. Secondary school levels of education in the 1970s

Secondary Level			
	Level 1	Level 2	Level 3
Grades	5 and 6	7, 8 and 9	10 and 11

Independence came in 1975 while I was finishing the first level of my secondary education. I chose, in Level 2, to take a technical course called Basic Electricity, at Escola Industrial 1º de Maio (1st of May Industrial School). It was a three-year course. At the end of my second year, in 1978, a big meeting was organized between Samora Machel (the first President of Mozambique) and all students in the capital city. He announced that due to lack of teachers in the country Level 3 would be temporarily suspended throughout the country so students of that level

could be trained to fulfil the country's need for teachers. However, Level 3 was made available, exceptionally, at the only university we had at that time, as preparation for students to get into the same university. This school was called 'Propaedeutic'.

After finishing Level 2 of secondary education I was selected to go to Propaedeutic. My colleagues and I were told that we were to do engineering courses, as the country lacked technicians. After finishing my Propaedeutic, two years later, we had a meeting with the Minister of Education, Graca Machel, who announced that the country could no longer afford to remain without Level 3 of secondary education; hence, no matter what our background, each of us would be selected to do teacher training. I was selected to become a teacher. After my teacher training I was directed to work at Instituto Agrario de Chimoio - IAC (Agriculture Institute of Chimoio), more then 1000 km away from my parents' home. At that time IAC was the only middle-level agriculture school in the country.

Figure 1.6. My first school was similar to this construction.

Becoming a teacher

I arrived at Chimoio on a February afternoon at the beginning of the 80s tired but excited. I learnt during my journey to Chimoio in a practical way how vast my country is, because in many places there were no houses or huts to be seen. At that time I did not know that I would repeat the same journey many times having always the same impression. Why are we heavily concentrated in cities if it is

possible to breathe and enjoy this pure air? Let me continue to tell you about my first trip to Chimoio.

It was my first time to be by myself, far away from my parents, and it would be so for such a long time. The journey started the day before and was troublesome; nothing was working or functioning properly at that time in Mozambique. The sounds and environment of the new place were very new and attractive. What I saw was a much better reality than the one I dreamed of. I thought, for example, that people were unable to cook because of the lack of tomatoes, oil and onions, but quickly I learned to use butter instead of oil and to cook without tomato and onion. This was the place where I expected to live for up to five years, and I ended up staying there for ten years.

I spent nearly 10 years in Chimoio. When I arrived there, the civil war was widespread and things were dangerous in many parts of the country. The country had shortages of everything. My school was attacked twice. The civil war ended in 1992. This event marked the advent of a third transitional society, the one we find ourselves in today. Mozambique is apparently moving from socialist/communist society to a market economy society. 'Apparently' because the country has been ruled since independence by the same political organization – FRELIMO who adopted initially socialism/communism, and in the FRELIMO leaders' discourse what is happening now is arguably just a strategy for building socialism/communism in Mozambique.

Chimoio is one of the smallest cities in Mozambique. It is the capital of Manica province, which has very beautiful scenery. The view can go from mountains to valleys, from green lawns to different colours of leaves. When I arrived in Chimoio, the city was famous because of its tidiness in contrast to the big cities like Maputo and Beira.

Manica had a unique technical high school where students could learn agriculture and veterinary techniques in the country. This technical school was 10 km away from the city and 60km away from the border with Zimbabwe. The main national Mozambican road, 'EN1', passed near this school.

The school, named 'Chimoio Agricultural Institute' (initials IAC in Portuguese), was under government control and was the only middle-level agricultural school

in the country. It received as much help as was possible at that time. However, the difficulties were enormous. Few resources (human or material) were available in the country. At one stage, all the teachers were technicians at the middle-level technical school. When I arrived at IAC, I was one of the few teachers with a university level education. After introducing myself to the directorate I had about three weeks to settle and organise my physics course.

I worked hard to organise as much information as I could to pass on to the students. My intention was to be an example that Mozambicans needed to work hard and quickly, at least to gain bread. When I went to the first class, I realised the difference between being a teacher and being trained to be a teacher. I spent about 20 minutes introducing myself, the Physics subject, and the schedule for assignments and activities for the semester. After that, I 'interacted' with the class in this way:

I – Do you think that we can start our course today as we still have 25 minutes?

Students – No answer.

In five minutes, I defined physics, the object of the discipline, the similarity with other sciences, and the importance of this unit in students' lives. And added:

I – Now we know what physics is, do you think that we can start the first unit (in Mozambique the subjects are structured by units) which is Mechanics?

Students – No answer.

I - Let us try to do it in the rest of the time.

In 20 minutes I explained everything what I knew about Newton's First Law and then asked the students:

I - What else would you like to know?

Students – No answer.

I – Thanks for being in this class I will be more than happy to help you with this concept wherever we meet, as all of us are living here.

When I went home I suddenly felt bad. I was expecting to hear something like 'Well done, can you improve this or that aspect of your explanation?' Or 'Can you tell us a bit more about this issue!' But this had not happened. Why? The answer was that the audience was formed by students and I was the teacher. **Teacher**! I was astonished by this concept. This meant that the audience did not have enough time to make sense of what I was saying and they were overloaded by scientific information. They were **students**!

I concluded that I was the one who had to guide students' learning processes. I started to question how to work hard enough to earn bread and at the same time be a teacher. In other words, how to be quick and also to give time to students to make sense of the physics content? I was lost between these two views. From whom could I receive help? I was one of the most educated teachers in the technical school. This was the way in which I discovered that teaching does not mean giving all the information at once. On the path of learning to teach I discovered also that sometimes students can ask things that I was unable to explain. And that the enjoyment of teaching was in my ability to involve students in searching for answers to these questions.

The story shows a complex reality that can be explored from several perspectives. One of these perspectives is that students are mainly taught to reproduce what they are being told in the science classroom without looking to their feelings, who they are, or their standpoints about the content delivered in the science classroom. A classic example is given by the perspectives of students of my colleague Mia Couto who had been doing teaching fieldwork in the countryside.

Figure 1.7. Is my mother responsible for my enculturation in science education?

[Students] behaved as if they were in a strange and adverse universe. They did not know the languages, were unaware of the cultural codes, felt themselves dislocated and were homesick for Maputo. Some suffered from the same ['dangers'] of the colonial explorers: ferocious animals, snakes, and invisible monsters. Those agricultural

> areas were, after all, the places where their grandmothers and all their ancestors had lived, but they did not recognize their inheritance. Their country was foreign to them. Worse still, they did not like this other 'nation'. Still more seriously, they felt shame to be part of it. (Couto, 2003, p. 1)

I am now, at the start of my doctoral degree, a teacher educator at the Pedagogical University in Maputo, struggling to understand myself, my culture, and the genesis of the problems that we are facing in Mozambique (racism, tribalism, patriarchal rule, lack of female emancipation, disease and poverty); how different/similar are Mozambicans to the rest of the world; and what are the possibilities of addressing our problems and identity in science education? Each of us in Mozambique, I believe, is struggling to solve our problems in his/her own way. In my experience, this general attempt can be characterized as: *I give to the society what I can so the society should reward me in a way that I will not face those problems*.

What I am giving to society should also contribute towards solving the general problems. For example, this research will emphasise that all of us are looking for the same better world and that one of the requirements to achieve that better world is to look at ourselves and our ways of interacting with others. Thus, I intend to analyse our culture, taboos and customs, including the hegemonic forces that drive our lives. My belief is that one of the major hegemonic forces we are dealing with is encompassed in the one view of science that we have in the science classroom in Mozambican schools.

For more than 10 years I have been teaching undergraduate students in the Physics Department, preparing them to become science teachers. My wish is to continue to be a teacher for the rest of my life. Although I became a teacher by chance, I cannot now dissociate myself from the teaching/learning process. As a science teacher and science teacher educator, my colleagues, students and I have a privileged role in promoting solutions to the problems created by Western science. This so-called Western or Modern science is a world view of science in that it is held around the World including Mozambique. Analysing my experience of learning Western science in Mozambique I come to the conclusion that I should call it *World Modern Science*.

Teaching World Modern Science

Earlier, in the 1980s, when I was educated to be a teacher, one of my educators asked us to write our vision about our future as teachers. The majority of us were there because of 'obligation'. We did not ask to be teachers. This was only a few years after independence. The majority of skilled people, including teachers who were Portuguese, had fled to Portugal. The country needed skilled people and the solution was to distribute students from higher secondary school into various sectors.

My answer to the educator's request was *I would like to not interfere in my future students' life. I wish that I will never be a hindrance for students to achieve their goals. I would like to identify students who want to study, and to help them*. Nowadays I still think the same, but in some cases I feel powerless to help students learn. I have been teaching Physics since 1983. In 1994 I took on the additional role of teacher educator. Since 2001 I have been working as a teacher educator only, struggling to show how a teacher can be a facilitator of the learning process.

As a Physics teacher in a secondary school, each year I told myself that I needed to find a way to keep students' motivation high throughout the academic year. When we started the year, I used to make a speech similar to this:

> You are here to learn. As you are here this means that you have at least nine years of experience of learning. Have you realised what determines the success of this activity? Learning involves communication. Without talking, expressing what you have understood, questions and doubts, you can't learn. By experience, I know that you do not like to talk because you are afraid of making mistakes and being laughed at by colleagues. Have you realised how comical it is to learn? Can you recall how the child learns to walk or to speak and how it makes the adults laugh? This means that unless we accept making mistakes it is not possible to learn. All of you here are in the same circumstances, you need to learn this unit, so it does not make sense to laugh at each other, and I do not accept it. This building was also made for you to make mistakes in order to learn how to do things right, outside of here, and I am here to help you.

After this speech my students are usually very active in the classroom until they get marks on the first test. In general, the participation level goes down for the rest of the year. This happened to me in several schools in different parts of the country. One of my thoughts was that students' participation goes down because of bad results in the first test. However, changing that situation did not seem to change students' attitudes. My students' behaviour made me also question why I am teaching. What is the usefulness of the Physics that I am teaching? I started this research thinking that if science could contribute to students becoming aware of who they are and to changing their living conditions then they would be more interested in learning.

I was trained as a World Modern Science 'transmitter' who understood science as impersonal, arising from the myths of 'cold reason', 'language as a conduit' and 'hard control' as referred to by Taylor (1996). From this perspective, science is not connected to any culture and students should find their ways of making the process of being inducted into World Modern Science as successfully as their teachers. These ways include memorization, Fatima's[2] rules (Aikenhead & Jegede, 1999) and the ability to live in two separate worlds inside and outside the science classroom.

Figure 1.8. Presenting my learning experience and how I became a teacher.

[2] Fatima's rules are a set of strategies to hide that the learning process is failing.

The world inside of my traditional World Modern Science classroom was characterised by a Universalist view of science, based on three assumptions: (a) reality is independent of humans' views about it; (b) this reality is always structured in the same way everywhere; and (c) the structure of reality can be, at least, partially explained. This view claims that many phenomena can be characterised, predicted, and controlled without bias: "the character of the natural world is unrelated to human interests, culture, race or sex. Ultimately, the concept is judged by the object, not the other way around" (Stanley & Brickhouse, 2000, p. 37).

My teaching dilemmas

The school where I first worked is located in the central part of Mozambique. At that time it was the only technical agricultural school in Mozambique, and it was a residential school. Therefore, students came from all over the country to attend the school.

The school was 10km from the city. Surrounding the school were vast fields with a few huts. There were no shops, cinemas or post office that students could access. Public transportation was working so badly that on many occasions students walked to and from the city. There was a bus used mainly to transport the school's support workers to and from the city but it spent so little time in the city that students couldn't used it to do anything. The teachers had to request the help of the school to travel to the city, usually only for emergencies

Today, I recognise that being away from my family caused me to begin to really care about my students, who were also away from their parents. Being a residential school allowed more interaction between the students and me, and probably helped me to develop a more empathetic relationship with them. This perhaps explains why I went out of my way to assist students with their learning.

My students and I used to visit each other and socialize. Can this period be described as being a 'teacher of life', as the relationship of student to teacher or vice-versa was always present? How did this situation change after I got married and started a family? Subsequently time spent with students was

drastically reduced to the duration of lessons, breaks between the lessons and sometimes in the school playground.

Although younger than most of my students, I was trying to substitute for their parents. It was a pleasure to listen to students, not only about their doubts but also their private lives. Some of these cases were so deeply complicated and private that I couldn't formulate any advice. Usually my reaction was: 'Let's see how you go in this matter'. I was surprised when students came back to tell me about their developments. I had thought that my answer was not helpful enough to receive feedback from them.

Figure 1.9. 60km from Cupane's first school there are Bushmen paintings on the rock hill paths in Chimanimani.

Figure 1.10. A rock hill in Chimoio.

I used to teach four science classes a week; each class had a minimum of 40 students. Each class had four sessions per week of 45 minutes. To allow physical experiments to be conducted the sessions were grouped, when possible, in pairs. I was working with a centrally developed and controlled curriculum. In his case, as the school was the only one of its kind in the country, the teachers submitted two assessment proposals to the Ministry of Education for examination and, after approval, they were administered to students. Hence, there was pressure to show that all the subject content was covered in the assessments. Each teacher was also required to report to the directorate of the school on the content that had been covered, what strategies were used and what the teacher would like to change, as well as the arguments supporting those recommended changes.

I never understand this requirement because, even when suggestions were made by the entire school, they were never implemented. For example, in the middle 1990s, my college proposed a hierarchy system for units. This set out the sequencing of units to be taken by students in each course. The response from the Directorate to this suggestion came nearly five years later in such a way that made no reference to the school's proposal. The system paid no heed to the challenges faced by teachers or their suggestions as to how better to face the challenges identified by practitioners.

My teaching philosophy supported the involvement of students in the teaching-learning process. I believed that if I made the effort to 'understand' the physics content then the students would gain the same knowledge if they also made an effort. The first step in involving students was for me to make sure they were participating during the lessons; hence, at the beginning of each year I used to make the speech reported in Becoming a teacher.

During lessons, I made efforts to bring to class examples from Mozambican social life, when appropriate. But these examples were not fully exploited because there was a huge content to cover. This often caused me to rush to complete the physics program. At the end of each lesson, students were given a 'huge' number of exercises to complete. In the following lesson, which was two or three days later, students were appointed to solve the problems given as home work on the blackboard. They were given marks according to their performance.

One of the dilemmas faced by me at that time was to understand the usefulness of what I was teaching to students and to Mozambican society. I wanted to include information about the local-indigenous culture and environment in my teaching (but I used to avoid this by saying my students and I did not speak the local-indigenous language). It was mandated to deliver all the subject content in the program. I used to tell myself that my role was just to deliver the subject content. The implications of teaching only the subject content were already established by the curriculum designer and my dilemma was seen as simply academic curiosity.

Another dilemma was that, although I related well to my students inside and outside of the classroom, my students were not obtaining the required grades to pass. The percentage of students finishing my unit with success was less than 50%. Although this was not seen by the school as 'a big' issue for the system (students could pass the class even though they failed one or two subjects), I was not happy with my role in their academic performance. The education system tried to convince me that this was the students' problem, which helped my self esteem, but at the same time I believed that I had some responsibility; hence, at the beginning of my postgraduate studies I wanted to address this issue.

Local-indigenous knowledge

In the literature, my science - the science of my people – that I want to include in my teaching is called 'indigenous' or 'local' knowledge. How then can I teach indigenous or local knowledge simultaneously with World Modern Science?

I suggest designating as *local-indigenous knowledge* (my) Mozambican knowledge and other knowledges that have similar characteristics.

I use the expression *local-indigenous knowledge* for two reasons. First, the terms *local* and *indigenous* are ambiguous but their combination has the meaning that I want to convey. The term *indigenous* evokes in me the pain and anxieties that Mozambicans went through during the colonial era; I understand it as a discriminatory term. Sometimes, though, 'indigenous' is used in a way that agrees with my understanding; it is widely used, so I cannot afford to exclude it from my vocabulary. The term 'local', even as a metaphor, is barely acceptable. For example, when understood as place, the incongruence is how can a place be an owner of knowledge? If it is understood as people who live in that place the difficulty is to accept that all people in that place think in the same way. Hence, if expressions such as 'Western knowledge', 'African knowledge' or 'local knowledge' are imposed they serve the interests of only a few. When I use the term 'indigenous knowledge', I understand it to refer to the African culture that exists in Mozambique.

My difficulty with the expression, 'local knowledge' also carries through to the term 'Western Science'. This term incorporates an essentialist view of science (see Chapter Four for details) which affirms that science belongs only to the West and to every single Western person.

My dissatisfaction with an essentialist understanding of Western Science, has led me to use the term 'World Modern Science'. My main argument for this is that although World Modern Science seemingly began [3] in the West, its subsequent development and our current scientific beliefs and practices are due to the participation of men and women from all cultures. This is the unique science that has been taught as school science in Mozambique. I am pleased that the so-called Western science continues to be taught in the Mozambican science classroom but I argue that it should be understood as 'World Modern Science'. This view promotes a non/essentialist perception of science. According to this view science belongs to people who have made the effort to be inducted into this discourse community. Non/essentialism is a counter essentialist theory and is explained fully in Chapter Four.

Have I said 'people'? According to essentialism there are indigenous and non-indigenous. As I am not happy with being placed in the indigenous category I see 'people' instead of indigenous and non-indigenous. Would I feel differently if I were classified as non-indigenous? I do not know, but I know some non-indigenous people who are not happy with this discrimination.

Why Have I Done this Research?

My main stimulus for doing this research was the feeling that I could do better that which I was doing: teaching. My dream was that there are rules that could make me, as a Physics teacher, better understood by my students. Indeed, I have achieved my objective: I can teach better by having Mozambican culture as a referent. I was transformed through this research. But instead of focusing on how

[3] This claim is supported by many scholars who argue that the Islamic world, India and China did not develop the science and technology that they discovered in the same 'successful' way adopted by the West (Chattopadhyaya, 2006; Collins, 1994, Sep.; Crombie, 1994, Nov. Nov.; Wallace, 2002).

to teach Physics, this research made me ask: (a) Why am I teaching Physics? (b) Who am I and who are my students? (c) Which common values are we (students and I) sharing given that we came from different ethnic groups? (d) What we are learning from each other in our teaching and learning of physics?

Another element in the complex process of learning/teaching are the students. Students have for most of the time been my preoccupation. In my view, students are linked to their environment and culture. This differs from my previous view which considered students as possessing knowledge and misconceptions that I, as a teacher, had to expand and correct.

One of the biggest problems faced by the country is the high rate of failure in school. In this study I have attempted to show how the situation can be overcome. The search for how students can learn better is a common goal (Aikenhead, 2000; Erickson, 2004). There is also a great concern for science education to promote local-indigenous cultures (Carter, 2004; Fanon, 1970; Harding, 1998; Semali & Kincheloe, 1999).

My PhD journey has been a rewarding experience of learning; it has helped me to improve my professional practice of science teaching. Through this study, I have consolidated my praxis as a teacher–researcher. As I am involved with student-teachers from different parts of the country, based on the insights from this study, each year I will focus on how one or more of our cultural aspects can be introduced in the science classroom.

I believe that I have contributed to science teaching in general, especially teaching that wishes to incorporate local-indigenous culture. I have shown in this study how science teachers in Mozambique can integrate teaching in their own lives, school lives and local communities, and I have outlined a curriculum that I name *a Cultural Model of Teaching*.

I developed the basis for proposing my Cultural Model of Teaching in my Masters Degree (Cupane, 2003). At that level I concentrated on classroom equipment, asking how can we use local available materials in the science classroom, that is, materials we use everyday at home, especially in our cooking, washing, travelling and eating. By doing so, my hope was that I could bring my

culture into the science classroom. Due to the constraints of my Masters Degree research I could not address, for example, the criteria for selecting everyday materials. I finished with the sense that I needed to deepen what I had done; hence, this doctoral study.

My doctoral study helped me to answer questions such as: How to bring my culture into the science classroom? Why my culture? Do I consider my culture as special, in relation to other Mozambican ethnic groups' cultures? Which culture do I start with in the science classroom, considering the rich Mozambican cultural mosaic? How do I address contemporary Mozambican cultural diversity (see pictures below) in the Mozambican science classroom?

Figure 1.11. As Mozambicans and individuals we have culture that needs to be addressed in the science classroom.

Figure 1.12. Mozambican culture includes our ways of cooking.

This research is part of the ongoing discussion about ways for schools to be vehicles of helping students to be critically literate (Bauer, 1992; Eisenhart, Finkel, & Marion, 1996; Hodson, 1999, 2003; Laugksch, 1999). The main feature of this concept is that citizens who are critical social thinkers will not damage the equilibrium of Nature and when necessary can act to restore it. Indications of how the equilibrium of Nature has been affected adversely are the devastation of forests, the appearance of the ozone hole, the message that human activity depends on a few sources of energy based on oil or coal consumption, hydro or nuclear power, while other sustainable alternatives exist such as wind, solar, tidal and biomass energy. The message that the best form of living in this world is to accumulate everything (e.g., knowledge, money, goods, power, land), however

this way of living contributes to unsustainability in social and natural environments (Hodson, 2003).

I argue that my Cultural Model of Teaching can help students in Mozambique to learn that in their interaction with Nature all of the community is involved. For example, to cut or to plant a tree in my culture is not an exceptional event, but what is missing is a broader awareness, or at least the ability to demonstrate in a practical way, that beyond meeting our immediate needs this activity can contribute to the welfare of our society.

The cultural diversity that characterizes the country will certainly influence the promotion of this Cultural Model of Teaching in Mozambique. I do not see any part of Mozambican culture restricted to one geographical place, hence the application of the Cultural Model of Teaching should address the following questions: which cultures, in a given school, can be promoted through a Cultural Model of Teaching? and by whom? Unfortunately, there are Mozambicans who cannot characterize their African (Mozambican) culture.

In this study I am posing many questions all of which I cannot answer fully because of constraints inherent to doctoral studies: limited time and resources. The questions are indications of recognising the existence of key problems that can be followed up after this research.

The way to answer the above questions determines the connection between school and society. The research conducted in my Masters Degree showed that Mozambican schools incorporate only a very small part of students' lives. In other words, what students are doing in the classroom is not much influenced by what they are doing at home, and vice versa. These findings led to the question of the usefulness of school for society (Cupane, 2003, p. 101).

Research questions

Thinking about my life, my learning and my professional experience and what I did in my Masters Degree stimulated the emergence of the initial research question of this Doctoral thesis: How can school science better serve the cultural

development of local school communities in Mozambique? In particular there are two specific research questions:

1. *What are the culture-sensitive teaching/learning strategies that have been shaping my own praxis? How effective have they been?*
2. *What are key opportunities and obstacles to making science teaching relevant to everyday life in Mozambique?*

These questions enabled me to analyse the development of my teaching skills and how teachers, especially in Mozambique, can develop with their own students, based on a centrally defined curriculum, a Cultural Model of Teaching that includes Mozambican cultures and that seeks to promote critical reflexivity in society.

I have attempted to take the reader through my research journey, some of the time diachronically and sometimes synchronically (Polkinghorne, 1997). The chapters of this thesis were not built at all in the order in which they now appear and thus the thesis partially obscures the process of my research inquiry. However, I have given details whenever possible to illustrate the dynamic nature of Mozambican culture and its education process. In contrast the diachronic aspect of the thesis shows my life and the life of my culture over time in such a way that their comprehension is linked to the chronology of events. "As temporally sequenced actions, research follows the logic of practice; not the formal logic of a positivistic approach to research, nor the argumentative reasoning of the constructivist approach" (Polkinghorne, 1997, p. 9). The feature that gives a diachronic perspective to this thesis is narrative. I have included narratives to give the sequence of events related to my life, Mozambican culture and the education process.

Overview of Research Process

I am using in this research auto/ethnographic methods (see Chapter Two). This way of doing research represents per se a milestone in my life as a researcher. It can be seen from this Chapter One that I am looking to myself and it will become clear that I make sense of my identity and its implications in science education.

Although this may be trivial for those assimilated (see Chapter Five) long ago into autobiographical studies, for me, who has been only in the positivist paradigm, it represents a culminating outcome of the two years of my earlier Masters Degree research in which I was stimulated in many ways to embrace this type of study. The story below entitled, 'We teach who we are', illustrates how I was taught and how I used to teach. In one word, the story illustrates the background that I brought to my postgraduate studies.

We teach who we are

I am twenty years old; a student-teacher doing the first year of a two-year course which prepares me to become a teacher of physics and mathematics to years 10/11. The Faculty of Education of Eduardo Mondlhane University in Maputo, where I am receiving teacher training, is located near the Indian Ocean. In general, it is a very nice place to be. It is a large space, separated from the city, occupied by a few buildings with large rooms; this is in contrast with the city and its suburbs, where we suffocated especially in the summer time. Maputo is a tropical city: hot and humid. My campus is enjoyable due to the maritime breeze.

At 2pm on one of the hottest March days I arrive at school looking forward to staying under a shed. Usually, until 1pm, the biggest shed was under the first floor. At this time of the day it is necessary to find a small shed or be in the classroom. My house is close to the university, forty-five minutes by foot, situated such that I could not catch a bus. Even if it was possible to catch a bus, my father would not give me money, arguing that it was very close. I arrive, sweating, looking forward to enjoying the breeze that refreshes the place. I have peace of mind because I have done my homework, consisting of mathematics exercises, which are somehow demanding of me. I volunteer to show on the blackboard to my colleagues and teacher what I did at home. Suddenly, while I am reproducing what I have done at home, my teacher, Igor Mozlewski, says: "if you keep working like that, in the future, you will not earn enough to buy bread". These words make the entire class laugh. I also laugh but I am very ashamed.

The impact of those words was not immediate: it took days, even weeks to construct the meaning. First, there was the comical aspect of earning bread. In

Mozambique, in general, people earn a monthly wage. If after a month there was the possibility of not earning enough for a loaf of bread how could I survive? This 'I' does not only mean me but includes my extended family and country. The thoughts were frightening, and when this meaning hit me I jumped to the question of why? Why had Mozlevwski told me that? My conclusion was that the harmony that I had in my life was an illusion. It was illusion to feel that everything was happening at the right time and in the right sequence. It was illusion to think that everything was well synchronised. My brothers and sisters were studying. My father was working and making sure that the family had basic needs, although sometimes the family was not able to cook. My mum many times was acting as the head of the family as my father was away.

Framing Mozlevwski's words under the 'illusion' that I was in, I concluded that I was slow. In this world there is time. That is why I am going to school in the morning and in the afternoon, my mother was going to hospital to visit one of my sisters, my father was sometimes away working. In this world, there is a time dimension, and time does not mean only chronology but also to be fast.

This research started 20 years after the critical moment that I have narrated as an introduction to this section. My learning of World Modern Science and teaching experience, enriched by a praxis of nearly 20 years, was characterised by realism (Schubert, 1986). Realism, in general, claims that knowledge is gained through experience. Naïve realism, in particular, affirms that our knowledge should be accepted or rejected to the extent that it is observable.

I started this research understanding that research is a journey where the traveller (researcher) chooses the means of transport (theoretical and philosophical framework) to produce knowledge in a certain field. Surprisingly, I ended up embracing an unfolding research design which differs from my previous description because, in this case, the theoretical and philosophical framework that I used was not entirely pre - selected; rather it emerged and evolved during this inquiry.

In my previous view of science the main aim of doing research in general was not to substantiate the trustworthiness of knowledge claims per se but to ensure that the knowledge claims satisfied the scientific community. The weakness of this view is that it ignored the majority of practitioners to whom the referred knowledge could be useful. When the goal is to meet some standard set by the scientific community to allow publication further measures of trustworthiness are not pursued.

In my current view of science, I am concerned with the scientific community represented by my examiners and by fellow Mozambican practitioners (colleagues, students, society). This professional community will determine the "pragmatic reasonableness" (Polkinghorne, 1997, p. 7) of my knowledge claims, seeking further evaluation from Mozambican practitioners or further research. The evaluation will come from those who have a similar experience to mine, and further research will arise from those who get engaged with this research but determine that my perspective differs from 'where they are'.

I view evaluation as a basic component of communication among Mozambicans, an element that is needed for us to improve our education system. I am hoping to receive from my colleagues an evaluation, not only that I have passed or failed, but of how the findings in my research inform and help their praxis and/or what modifications are needed for them to make sense of their own teaching. Hence, I have combined formal and personal voice for them to understand me from my (our) reality. How my perception of that reality has changed is shown by the following chronogram (Table 1.2.) that indicates some critical events in my research.

Table 1.2. Chronogram of some critical events in my research.

Childhood and induction into World Modern Science (Chapter One)	1961 – 1982
High/Technical School teacher (Chapter Three)	1983 – 2000
Teacher Educator at Pedagogical University (Chapter Three)	1994 – 2000
Master of Science Education degree program	2001 – 2003
Start of PhD degree program	2004
Fieldwork – 12 May to 09 July	
I - Interviewing my colleagues - Appendix B	2005
II – Interviewing my former students - Chapter Three	
Submission of my Thesis	2007

My understanding of science, through this research, has shifted from positivism (realism) to postpositivist, poststructural and postmodern standpoints, which affirm that the format in which this research is reported reflects my epistemological view that knowledge can be understood as an agreement among scholars (Polkinghorne, 1997). A key factor that influenced the development of my understanding about research paradigms was my first encounter with Palmer's (1998) question: *Who is the self that teaches*? My surprise was likely a result of the positivist or dualistic research paradigms that I had brought to my journey. Palmer's question helped me to realise that Mozambican education improvement requires, first and foremost, enhanced self awareness of its participants: teachers, students, stakeholders, and society in general. It does not comprise only the upgrading of teaching techniques, as I thought initially. In other words, I needed to understand myself and my culture before I went further.

Figure 1.13. My view of science includes the life that I have with my family.

I started this journey during my Masters Degree thesis which probably illustrates how difficult it is to change from a positivist to a non-positivist research paradigm. At that time when I accepted the evocative call to embrace qualitative study my intention was to study my culture from my inner landscape. I ended up studying it as a participant in Mozambican society.

The acceptance of being the central focus of my research represents a lot for me. It represents a form of decolonization and awareness of many forms of colonization. It becomes clear that although my place of birth, my skin colour, and

my gender do not determine what should be taught in schools, if they are not considered then schools lose the chance of having meaningful teaching. Hence, all of us are important for our contribution to how education should be, particularly in Mozambique. In this research I express my consciousness about the teaching of science in Mozambique and probably in the rest of the world. So the immediate question in my research becomes: how do I express that opinion in a trustworthy way? I address this question in the next chapter (Chapter Two).

Organisation of the Thesis

I have organised this thesis in three main sections that encompass seven chapters as illustrated in Table 1.3.

Table 1.3. Structure of my thesis.

<table>
<tr><td>Section 1: Research Questions</td><td colspan="2">Section 2: How I addressed emerged and initial research questions</td><td>Section 3: Culmination of the Thesis</td></tr>
<tr><td rowspan="2">Presents the researcher, the research questions and develops the theory and method that is used in the research</td><td>Subsection 1</td><td>Subsection 2</td><td rowspan="2">Reflects on the process of building this thesis, the outcomes achieved and perspectives on future research</td></tr>
<tr><td>Initial research question: What are the culture-sensitive teaching/learning strategies that have been shaping my praxis? How effective have they been?</td><td>Initial (What are key opportunities and obstacles to making science teaching relevant to everyday life in Mozambique?) and emergent research questions.</td></tr>
<tr><td>Chapter One: Introduction Chapter Two: Critical Auto/ ethnography</td><td>Chapter Three: Critical Reflection on my Science Teacher Educator Practice (1994-2001) Appendix B: Science Teaching in Mozambique</td><td>Chapter Four: Who am I? – A Cultural Perspective Chapter Five: Mozambican Culture in the Science Classroom Chapter Six: A Cultural Model for Multiscience Teaching</td><td>Chapter Seven: Closing Reflections</td></tr>
</table>

I hope the structure of my thesis portrays my transformation and helps the reader to understand the process that supports my knowledge claims throughout this research. I emphasize that this is an unfolding research inquiry; hence, the definition of terms, procedures and methodologies, conclusions and reflections are distributed throughout the thesis.

In Chapter Two I build the theory and method that guided this research. In this way, Chapter Two gives my view of critical auto/ethnography and its situatedness among educational research paradigms. The chapter also discusses the quality standards and ethics that I am considering in this research.

An exception to what I said in the previous paragraph is found in Chapter Three and Appendix B: Science teaching in Mozambique, where I am answering my specific research question 1. The process of answering this question is enlightened by social constructivist theory that I developed in my Masters Degree. It was the latest theory that I had to analyse my practices as I collected the data used in this research before developing new theories and concepts. However, my conclusions in Chapter Three are reviewed in Chapter Seven under the theories and concepts that I developed subsequently in this thesis.

Three research questions emerge in this research: (a) Who am I?, (b) Why should Mozambican culture be included in the classroom? (c) What is the usefulness of having Mozambican culture in the science classroom? Chapter Four addresses my first emergent research question, seeking to know how I define myself culturally. In this chapter I discuss the trustworthiness of the sociocultural understanding of myself, and consequently of other Mozambicans, as 'indigenous', using theories of essentialism, nonessentialism and non/essentialism as well as theories of dualism, nondualism and non/dualism.

Chapter Five addresses the second emergent research question that seeks justification for the inclusion of local-indigenous knowledge in the science classroom. And Chapter six addresses the last emergent question in this study that directed me to look at the aims of science education in Mozambique. The introduction of Mozambican culture into the science classroom should not be the goal *per se*, nor should this process be held up as a beacon of hope; rather, I argue that inclusion of culture can help students and teachers to become vectors of critical reflexivity.

In Chapter Seven I revisit and reflect on the main outcomes of the research. One salient aspect is the uses of boxed text throughout the thesis to express different perspectives on the issues under discussion. I felt during my research

that to use only one voice did not allow me to express fully the different thoughts that I had and that this problem is minimised by the use of boxes (see Luitel & Taylor, 2007).

Summary

Overall, I hope the reader can see the flow of my thesis and understand: (i) how I have been enculturated, acculturated and assimilated (see Glossary) in my society and in science teaching, (ii) the anxiety created by the contemporary way of educating Mozambicans, and (iii) how my research questions seek to assist the struggle to overcome this anxiety.

My hope is not driven by a narcissist intention but a desire to use my experience to establish a platform on which the incorporation of local-indigenous knowledge can be valued and have comparable, if not equal, value to World Modern Science.

This research has enlightened me about how to promote Mozambican culture through curriculum change in my praxis.

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Chapter Two: Critical Auto/ethnography

Introduction

> [Critical] auto/ethnography concerns knowledge of the self, which is not easily constructed, but which is, according to a German saying, "the first step to improvement." In addition to the idiosyncratic and mere private knowledge of Self, auto/ethnography concerns the position, behaviour, and experience of Self as an interesting, significant example of universality, the concrete realization of culture in a concrete, situated, and embodied person. If it is true that talking about others implies talking about oneself, then, conversely, talking about oneself also implies something about others. (Breuer, 2005, p. 109)

Figure 2.1. The excavation of my inner landscape implies also excavating the identity of my people: family, community where I live, my ethnic group and Mozambicans in general.

This chapter describes the methodology I am using throughout this thesis to answer my research questions (see Chapter One). The main goal in this chapter is to show you, the reader, how and why I have conducted my research using mainly critical auto/ethnography. Critical auto/ethnography is an autobiographical genre of writing. It is research that displays multiple aspects of individual awareness about the author's cultural embeddedness. In this method, researchers recall and create facts, recall and create nodal moments[1] that help them to make claims.

[1] Nodal moment – For self-study researchers, nodal moment(s) are those moments seen as determining the course or events in one's life. In the field of teacher education, nodal moments are

Therefore the story of my life is not a neutral attempt to mirror the facts in my past life but is a starting point to design more critical perspectives on the teaching-learning process (Ellis & Bochner, 2000).

Critical auto/ethnography allows me to express my values and look at society as both researcher and participant (Luitel & Taylor, 2005, Apr Apr; Song & Taylor, 2005). My aim, by acting as a researcher and as participant, is not simply to describe and explain what is occurring in science education in Mozambique but to make claims vigorously about the inequalities, myths and hegemonies that drive the process.

My claims and descriptions sometimes will be expressed in an impressionistic style (Maanen, 1988), giving an evocative (Ellis, 1997) account of what is being done to improve the process and showing my engagement, hoping that this enables all participants in the education process in Mozambique to share our understanding and vision.

Critical auto/ethnography allows me also to focus on my and others' experiences of teaching and learning without moving my study to the field of *ethnography*. The others' experiences of teaching and learning that I have selected do not pretend to represent fully a particular social group or given culture (Bilton et al., 2002) but I felt that their stories were similar to mine and therefore enhanced the cultural significance of this research. I found those experiences through interviewing.

One of my purposes was to use the interviews as a source of inspiration for constructing my stories about the characteristics of culture-sensitive teaching/learning strategies that I have been using and to help me evaluate their effectiveness (Specific research question 1 addressed in the next chapter). In these stories the preoccupation is not the representation of my interviewees, rather it is to give the reader a richer understanding of my claims through facts and fictions (Gubrium & Holstein, 2003; Palmer, 1998). In this way I am acting in this research as a *bricoleur* (Denzin & Lincoln, 2005), creating whatever is necessary

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perceived as the ones determining how to teach, and impel educators to learn how to teach. Those moments are the ones that help the reader to see the self and others

for the reader to understand my claims. The stories are in general followed by interpretive commentary. “Perception itself must be interpretive; the perceiver, in the partial frameworks of her or his own lived life, must make sense of the appearances of things as they present themselves to her or his consciousness” (Greene, 1994, p. 438). The critical hermeneutic process of interpretation is made considering my values then and now.

My initial research question ‘How can school science serve better the cultural development of local school communities?’ also reflects my encounter with Palmer’s (1998) question: Who is the self that teaches? I cannot answer the question ‘who am I’ without characterising my community and vice versa because of our dialectical relationship (Roth, 2005). Furthermore, my intention in this thesis is to go beyond discovering Mozambican identities by discussing possibilities of how to develop, culturally, the same identities. In order to address these questions I needed to resolve issues such as: How do I make myself the centre of my study? How can I study myself objectively? I could not find a response among the positivist and post-positivist paradigms in which I was acculturated (see Glossary) and because:

> … observation is not value-free, as the positivists assert. Indeed, what one observes, not to mention how we observe it, implies a set of values in the observer. Furthermore, some of the most important things in human behaviour are things that cannot be directly observed, such as intentions and feelings. (Anderson, 1998, p. 5)

My values at the beginning of this study are summarised by the contradiction that I was feeling at that stage. I beginning this research seeing the science that I was teaching as ‘Western science’ and the contradiction that I was feeling was ‘how could I teach Western science in Mozambique, an independent country?’ This research helped me to resolve this contradiction and awaken other values. I invite you to ‘see’ how this happened.

Through readings and notes from Peter Taylor’s research methodology classes that I participated in during my five years at SMEC I understood that I needed a degree of detachment from myself. In other words, I needed to understand my values, the values of my society, the values of the rest of the world, and an

understanding of the extent to which these values are promoting my freedom. I started to embrace postmodernism (see next section for details).

Thus, critical auto/ethnography in this research should be seen in the context of postmodernism and also poststructuralism, critical hermeneutics, feminism, and multiculturalism (see Chapter Four) theories. My understanding of these theories is that I can study myself as a member of a given culture; consequently studying simultaneously my culture. I understand also that all cultures have the same status and, in this perspective, are equal. Cultures help their members to live their lives, and to interact with each other and the 'external' world. One of the consequences of this stance is that different knowledge systems, including scientific knowledge, that are embedded in different cultures, are equal in status.

The Research Paradigms that I Have Embraced in this Study

This research is strongly influenced by our Mozambican history of being colonized by Portugal. During the colonial era, events in Mozambique were driven by the colonial power: how to teach, what to teach, and how to live, even the different identities that were to be worn by different people in Mozambique. I was never comfortable, as were many Mozambicans, with my 'indigeneity' identity given by the colonial power.

> After deciding to use a non-positivist research paradigm I have been struggling to use it consistently. I am not sure if the present thesis also represents the end of an internal conflict between my positivist or dualist paradigm that I was educated in and a non-positivist paradigm which I found adequate for answering my research questions. Many times I have found myself occupied with general theory instead of looking to myself or my situation. It is hard to shake the yoke of a positivist hegemony that has been imposed for centuries.

As an intellectual exercise, at the beginning of this study I tried to find out how sustainable it was to see myself as indigenous, traditional, modern or something in between. My arguments were that regardless of the colonial philosophy of indigeneity I am a Black who was born in Africa and I am the one who was acculturated into World Modern Science teaching to the extent that I

became a promulgator of it; furthermore, I am writing this thesis while living in Australia doing postgraduate studies. Because of this, I could be traditional, modern or something in between. My reading about my identity confirmed my refusal of a single identity to describe me, Mozambicans and other people in the world. It became clear that this is a *postmodernist* stance.

Postmodernism

For some 'postmodernism' conveys the meaning of an era after modernism that does not have anything to do with modernism. I do not agree with this understanding. The era that we are living in is under the strong influence of modernism and many times is characterised by modernist values only. I acknowledge the development brought by positivism and that I am moving back and forward between modernism and postmodernism.

A postmodernist view of the world can be characterized as unstable and sceptical. This view refuses to accept that the world is explained by single theories, called meta-narratives, which pretend to explain how society develops and what we should believe.

> For the postmodernists, such grand narratives are delusions that lead directly to authoritarianism, as these doctrines are imposed by those who claim to have the unifying key. Instead, postmodernists celebrate diversity and difference, since this can reinforce dislocation and offer an open, unpredictable future. (Bilton et al., 2002, p. 518)

The postmodern era is also characterised by an intense and extensive economic and cultural interaction. People are literally overloaded by information from all over the world through different media. Prices are no longer stable due to international influences. This is called *globalization*. The evolution from the modern to postmodern era is summarised in Table 1.

Table 2.1. The evolution from modern to postmodern era.

Period (century)	Characteristics	Examples
17th	Foundations of rational World Modern Science	- Descartes philosophy and - Newton's scientific theory
18th	The Enlightenment (rationalism) period	- Faith in science and reason - Faith in human rights and power (political revolutions)
Early 19th	Moves against urban industrial modernity	- The romantic movement in literature - Faith in progress through World Modern Science: positivism
Late 19th /early 20th	Doubts and fears about the consequence of modernity	- Nietzsche's philosophy - Weber's sociology
Early 20th	Simple model of truth and reality are questioned	- Einstein's work - Picasso's and Magritte's paintings
Late 20th	Fragmentation, cultural diversity, plurality of identities, Poststructuralism in cultural theory	- Derrida's, Benjamin's, and Baudrillard's work. - It weakens the difference between 'high art' and commercial culture.

Adapted from Bilton et al. (2002)

Poststructuralism

My reading of postmodernism brought to my attention the existence of *poststructuralism*. What are poststructuralism and *structuralism* and how are they related to my study? Structuralism adds objectivity (**scientific** objectivity) to the domain of qualitative studies. In this way, structuralism addresses one of the problems identified by some critics that qualitative studies are characterised by subjectivism and/or impressionism without a means to show the truth claimed in their texts. For structuralism, the meaning and significance of the text does not

convey the author's message but conveys only the meaning that the words have. Hence, who wrote the text does not matter as all texts are variations of 'certain basic universal narrative patterns' (Denzin & Lincoln, 2005).

> Hence the idea that "language speaks us", rather than we speak language. We don't originate language; we inhabit a structure that enables us to speak; what we (mis)perceive as our originality is simply our recombination of some of the elements in the pre-existing system. Hence every text, and every sentence we speak or write, is made up of "already written". (Klages, 2004, p. 1)

Structuralism can be seen as essentialism (see Chapter Four) applied to literary texts and may be worse than essentialism as it refuses to recognise the legitimacy of 'adulterated' language. Structuralism refutes my existence as an individual by refusing my individual perception of our (Mozambican) reality. According to structuralism, Mozambican reality will be always told by the same structure in a text. This implies, for example, that 500 years of colonialism in the Mozambican case will over time be seen in the same way (Klages, 2004). In this way structuralism refuses changes (development) in the language and in interpretation of colonialism.

Poststructuralism, as proposed by Derrida and Foucault, rejects the notion that fixed meaning will always be extracted. According to Foucault, it is possible to find a pattern within the texts influenced by the power structure and relationships in society, while for Derrida there are no constraints on the interpretation of a text. Jackson (2006) affirms that Derrida and Foucault agree on multiple interpretations but disagree on the characterisation of the texts.

Foucault's perception of poststructuralism aligns with dialectical thinking and is closer to my understanding of poststructuralism in Mozambique that our social reality, especially the education system (formal and informal), cannot be perceived in any fixed way called a 'structure'[2] for all of us Mozambicans. In other words, its meaning depends upon the reader in a way that cannot be

[2] Structure should be understood as that which gives meaning to the text in the same way that individuals get a sense of who they are according to the structure that they are within: family, school, community or nation.

characterized. This interpretation also depends on the reader's ability to understand the structure(s) that have influenced the construction of our social reality, namely colonialism, the struggle for our independence, civil war and natural calamities that we went through and that are still manifesting. By contrast, 'structuralism' means that our social reality always has the same meaning for everyone.

Figure 2.2. Students do not express themselves in the same way although, in some cases, they use the same language.

My stance is that language and phenomena are changing all the time. I can be understood by my readers because we share the same experience but from different perspectives and we are reading the same experience differently. In this way, "language is a product of the individual writer's mind or free will, meaning that we determine what we say, and what we mean when we say it" (Klages, 2004, p. 1). Language, therefore, expresses the meaning that I want to convey but it will be understood according to the reader's background.

Readers have different backgrounds; therefore the understanding of this thesis will depend on the reader's background, a background shaped by historical, cultural and economic forces. This poststructuralist stance is seen by positivists as "an attack on reason and truth" (Denzin & Lincoln, 2005, p. 8; Kincheloe &

McLaren, 2005). However, poststructuralism is a particular manifestation of postmodernity that links language, subjectivity, social organisation and power.

> Language does not "reflect" social reality but rather produces meaning and creates social reality. Different languages and different discourses within a given language divide up the world and give it meaning in ways that are not reducible to one another. Language is how social organization and power are defined and contested and the place where one's sense of self – one's subjectivity – is constructed. Understanding language as competing discourses – competing ways of giving meaning and of organizing the world – makes language a site of exploration and struggle. (Richardson & St. Pierre, 2005, p. 961)

Hence, poststructuralism appeals to me as a writer to understand myself and my values. The driving force of my writing, in turn, emphasizes my humble intention of not writing a universal truth.

Feminism

Poststructuralism helps to understand the struggle made by women all over the world for their emancipation. This thesis is also shaped by the feminist movement in the sense that if, on the one hand, I see the need to promote our (Mozambican) culture to the extent that it influences our decisions in our everyday life (especially in the field of science education), on the other hand I will simultaneously analyse our culture to depict inequalities promoted by our practices. One of these practices is shown by the following story called 'the scar on my left arm'

The scar on my left arm

It is around 6pm, on one of the hottest January days. My mother has just finished preparing dinner for us. We are five brothers and sisters and her. My father, as usual, is away working for his family. While we are having dinner, one of my sisters points to the scar on my left arm and asks me: How did you get that scar?

I replied - It was our cousin Meledina who did this, wasn't it mum?

Mariana (our mother) said, yes, as I have told you, it was on a cold morning when my mother-in-law and I were working on the farm near our huts.

We use to have fire in the centre of the hut, where we could cook our food and keep the hut warm. So it was common to find all the family in the hut, especially on cold days. The hut was also used to store maize and other products from the farmer. It seems that the smoke from the fire helped to keep away insects from the maize and other products.

You were nearly two years old. On that day, we left you in the care of Meledina, who was another child around eight years old. Meledina was distracted and you rolled over and accidentally put your elbow in the fire.

One of my brothers asked - He did not cry? How and why was he so badly burned?

My mother said - He cried loudly that both of us (my mother-in-law and I) could hear him clearly but I could not leave the field. After 30 minutes or so of listening to him screaming, my mother-in-law said, in an ironic way, "Don't you hear your son crying? Go and check what is happening with him?" As you know, I was obliged by custom to continue working with my mother-in-law until she as my elder had given me permission to go to see what had happened.

Meledina, after discovering that he had burned his left elbow, tried to put him some clothes on him to hide his injury.

My mother, when she told us this story, showed anger and hatred towards her mother-in-law, calling her a 'witch'. The feeling of my mother towards her mother-in-law and my own feelings put me in a dilemma. I perceived from my grandmother, on many occasions, an ethic of care. Thus, this story shows how women in general were oppressed not only directly by men but also by accepted rules in the society. After hearing that story, I realise now that I took the decision to stand up for feminism, as women's oppression made me suffer, leaving me with marks that will remain until the end of my days on Earth.

The experience that my family went through during my elbow burn appeals to *women's emancipation.* I understand 'women's emancipation' as facilitating *women's agency*. I came across the term *women's emancipation* after

our independence. It was one of the slogans of the FRELIMO (Mozambican Liberation Front) movement.

A lot has been done for women's emancipation in Mozambique. Our Prime Minister, several ministers and very high positions in the government are occupied by women. In many schools and districts the heads are women. Many women have made notable progress in scientific and business careers which was unthinkable some decades ago. Probably the main question in Mozambique in relation to feminism is whether those hundreds of women see their position as an advancement of the feminist movement and not a replacement of men's rule by women's rule as 'compradors' (Ashcroft, Griffiths, & Tiffin, 2000).

The feminist movement addressed the gender inequality that was continued by capitalism. In the eighteenth century, feminists were concerned to extend the concept of 'classical liberalism', perceived as the right for freedom, moral determination and individual happiness, to be applied also to women. In the 'enlightened' period the classical liberalism concept was applied to human beings characterised as rational; women faced the problem of not being considered as rational as men (Bilton et al., 2002).

The second wave of the feminist movement appeared during modern society. This feminism helped to solve the problem addressed by the first movement by demystifying the belief that sexual inequality was natural and consequently should be accepted throughout our lives. The second movement tried to understand deeply the reasons for female oppression by including in their search what was considered 'private' such as:

> … sexual division of labour in the home, and sexual relationships. Aspects of women's subordination that were usually accepted without question, such as unequal pay and discrimination in the labour market, domestic violence, rape [were also considered]. (Bilton et al., 2002, p. 489)

The view of this movement was that all these inequalities were due to the way that society was organised. Hence, reorganising society could address these problems.

The society was seen as divided into two spheres of life: *public* and *private* or *domestic*.

The public sphere was seen as the male domain "characterised by paid work, the market, the state, and politics, and was seen to be characterised by objectivity or impartiality" (Bilton et al., 2002, p. 490), while the private or domestic sphere was described as women's domain destined to the care of children and other members of the family. This sphere was seen as a place of emotional and impartial relationships linked to nature and instinctual behaviour. This was the sphere where future citizens were prepared to take their role in the society.

The two spheres were connected by the fact that the men lived in both of them. Feminist theory shows how the two spheres are connected and how the distinction between them has a political agenda.

Uses of postmodernism and poststructuralism by feminists

Today feminist theory uses postmodernist and poststructuralist epistemologies to enhance the struggle against inequalities in gender relationships and challenges those theories on what is perceived as treatment against feminist goals. Postmodernist theory is used to solve tensions within feminism which are, for some women, what was portrayed by the second wave of feminism - a false universality for what in reality were White, middle-class, Western women's experience of subordination. In other words, in some countries, "racism changed the very basic experience of gender inequality" (Bilton et al., 2002, p. 527). This issue leads to questioning the relationship between enlightened feminism and modernist thinking.

Critical hermeneutic theory

This study has been shaped also by critical hermeneutic theory as I am assuming it portrays my interpretations of the educational process that occurs in Mozambique, in my society and within myself. Critical hermeneutic theory (Kincheloe & McLaren, 2000) affirms that facts do not speak by themselves; hence, we need to share our understandings of our lives to improve them. This sharing has as a pre-

requisite the perception of how we are living and the search for better ways of living which are both manifestations of interpretations. My critical hermeneutic approach is to understand the science education that occurs in Mozambique and our lives as 'connected knowers'.

Figure 2.3. Critical hermeneutic theory requires seeing the world from different perspectives.

My research paradigms

The theories that I have included in this study suggest that this thesis uses several research paradigms in an holographic[3] (Henderson & Kesson, 2004) way. The research paradigms included in this hologram are *Interpretivism/ Constructivism*, *Criticalism*, *Representationism* and *Integralism*. I have excluded from the hologram *Positivism* and *Post-positivism* because I am not trying to prove if I am right or there is a single right way of living (teaching and learning) in Mozambique.

How do Interpretivism/ Constructivism, Criticalism, Representationism and Integralism differ and how can they help me to achieve my goals? The main difference is in their focus, methods, quality standards, their sources and the period when they appeared in the field of science education. These research paradigms help me to achieve my goal as I am looking to the educational process in Mozambique from different perspectives. In these perspectives I am concerned with my and other's perceptions (meanings) of our reality; how we can emancipate ourselves, how we are interconnected and how together we can

[3] This means that I do not subscribe to any single research paradigm and each of them does not have fixed boundaries. I am arguing that to understand fully myself and my world I need all research paradigms interconnected in a holographic way: all of them contribute to the understanding of the entire world in small parts "as the whole consists of its parts, so each part contains the whole" (Henderson & Kesson, 2004, p. 43).

improve our lives. The characteristics of the different research paradigms that I am using under the research method of auto/ethnography are summarised in Table 2, called ‘Major Research Paradigms’.

Trustworthiness of critical auto/ethnography

‘Auto’ and ‘ethnography’ are separated by a slash because of four reasons that underpin my use of critical auto/ethnography:

(1) The first is my dialectical relationship (Roth, 2005) with my society. I was not born isolated from others. Education, professional praxis, and cultural and political values reflect my society and the events that have occurred there.

(2) My intention throughout this research is to avoid narcissism (exaggerated love of self) and the pretence of absence of flaws in my educational practice or life (Dickinson & Pincus, 2003). My wish is to interpret my actual experience with some of its aspects (re)created in the form of stories, according to different theoretical and philosophical views that have governed my life; and to understand my old and new standpoints in relation to the educational process in Mozambique. The (re)creation of stories helps me to produce space between me as participant and researcher so that I can describe and analyse my ‘experiences’ (Ketelle, 2004). The non-narcissistic quality of this research allows the reader to feel engaged by this thesis (a) to understand my view of the Mozambican educational process and (b) to reflect on his/her own practice (Luitel & Taylor, 2005, Apr Apr; Song & Taylor, 2005). I consider Mozambican educators who are interested in culture to be my special readers, and my thesis is a contribution to the dialogue about the lives we are trying to promote in Mozambique.

(3) My intention is to avoid being an external-ethnographer who could ask ‘how do educators in Mozambique make sense in their lives?’. Instead, I am an insider ethnographer trying to find out ‘how do we educators in Mozambique make sense of our lives?’. In this way I am not claiming that this research can be generalized to all teachers in Mozambique; I am claiming, yes, that this research can be adapted by any educator who feels enlightened in Mozambique or in the rest of the world (Cohen, Manion, & Morrison, 2000).

Table 2.2. Major Research Paradigms.

	Modernism		**Post/modernism**			**Post/post/modernism**
Source Paradigm:	**Natural Sciences** 'The Scientific Method'	**Modified Scientific Method for Social Sciences**	**Anthropology/ Hermeneutics** 'Interpretive turn'	**Critical Studies** 'Reflective turn' 'Critical turn'	**Literary/ Culture Studies** 'Cultural / literary turns'	**Integral Philosophy** 'Ecological turn' 'Spiritual turn'
Arrival in Sci/Maths Educ:	1970s	early 1980s	late 1980s	early 1990s	mid 1990s	early 2000s
Educational Research Paradigm:	Positivism	Post-positivism	Interpretivism/ Constructivism	Criticalism	Representationism	Integralism
Focus:	**Explanation** (Objectivity)	**Explanation** (Objectivity)	**Meaning** ([inter]subjectivity)	**Emancipation** (power & agency)	**Difference** (self-other dialectic)	**Balance** (holism, pluralism)
Methods:	Experimental	Surveying - questionnaire - interview - non-participant observation Correlational Quasi-experimental	Participant-observation Ethnography fieldwork (*Erickson)* 4th Generation Evaluation (*Guba & Lincoln*)	Critical action research Policy critique	Auto/ethnography Writing as inquiry Fictionalisation Narrative inquiry	Mixed paradigms - Henderson & Kesson's (2004) 'curriculum wisdom' - Wilbers 'integral perspective'
Quality Standards:	Validity & Reliability 'controlling conditions'	Validity & Reliability 'triangulation' - of data - of methods - of theories	Legitimation - trustworthiness • credibility • dependability • confirmability • transferability • fairness - authenticity	Praxis [of reader & researcher] - pedagogical thoughtfulness - critical reflexitivity - re-envisioning	Representation 'crystallization' - polyvocality - verisimilitude - ambiguity - playfulness - paradox -literary criteria	Wisdom [under development – watch this space!]

Adapted from Taylor (2006)

(4) My intention is to awaken the dimension of the 'vulnerable observer' mainly among educators who are interested in education and culture. This is the dimension that makes educators go beyond to a connected knower level. Educators' concerns are not only 'to transmit' curriculum content but to make that content useful to students' lives because students' lives are also educators' lives. Education, from this dimension, goes beyond classroom or school activities (Behar, 1996) and the diversity of Mozambican lives is portrayed in the following images.

Figure 2.4. A Mozambican hut with a child.

Figure 2.5. One of the luxurious hotels in Mozambique.

Auto/ethnography allows me to share (and to invite others to do so) my lived experience in society and schools in Mozambique.

Vulnerability is achieved by disclosing our presence in both the world that we would like to transform and envisioning our presence in the world that we are helping to build. "This requires varying degrees of self-disclosure for the researcher" (Etherington, 2007, p. 611). The disclosure occurs with the extensive use of 'I'. For example, in this research I will have achieved the quality standard of vulnerability if the reader can understand how I have been both colonized by learning and teaching World Modern Science and a colonizer by facilitating the process of acculturation for other Mozambicans into the same World Modern Science.

The previous paragraph illustrates how difficult it is to be a vulnerable teacher or researcher: I cannot present myself always as a hero or victim. I am wrong! The concepts of hero and victim that I have do not help to explain vulnerability as well as does the concept of 'agency'. I understand agency as the ability to influence events in my own life. Hence, vulnerability will be shown to the extent that I can show my victories and failures in the struggle of constructing the better world that I want also for myself without allowing further harm to me.

Vulnerability 'humanises' the research and makes it accessible to other human beings. In this way it constitutes one of the quality standards for this research. What are the other quality standards that should be used by the readers in this research? In other words how are my knowledge claims in this research rendered justifiable? The problem of justifying knowledge claims comes along with the division of the world into matter and spirit (see Chapter Five). One of the consequences of this stance is to justify the correlation between our ideas/knowledge and the world that we observe. In general, this is what scientists of World Modern Science are aspiring to do: matching scientific laws with what occurs in the world. However, the same World Modern Science, especially Einstein's relativity theory, negates the independence of the observer and observed and shows how observation in one context can be translated by mathematical formulae to observations in other contexts. In summary, relativity theory negates the independence of the observer and the phenomena!

The issue of matching the products of research and 'reality' has dominated the world since Plato, who was convinced that "objective truth could be "seen" by the eyes of the mind or grasped by disembodied reason" (Greene, 1994). According to this view the 'reality' (nature or other phenomenon being studied) can precisely be represented by symbols, in general words (language). Hence there is clear distinction between *knower* and *known* which is "out there" (Greene, 1994) waiting to be discovered.

In this view the knower and known are distinct entities, knowers can dismiss their feelings and beliefs (body) that distract them from grasping the World as it is. René Descartes referred to this status as *naked mind*. In general this

status of *naked mind* was achievable by men. *Naked mind* was then characterized by human will and consciousness while the human body was linked to feelings and beliefs; this *naked mind* is called nowadays the 'disembodied mind' (Greene, 1994).

The logic of the disembodied mind in the 18th century in France and England penetrated into many spheres of life and was responsible for repression/suppression of what was seen as superstition and emotions in the process of reasoning.

> When people joined together in any collectivity, it was thought, emotions like enthusiasm or some fanatic feeling of jealousy were likely to overwhelm good sense and lead to overthrow of social orders, the stability of which was assured by the rule of rationality. (Greene, 1994, p. 428)

The 'Enlightenment period' began the domination of the world by one group or point of view that conceived the world as homogenous, including the different people living in it, with one unique exception: those who are Black are stupid. Many people have challenged this point of view, including Hegel and Karl Marx for whom knowledge is constructed through activity. However, even nowadays, the idea established in the Enlightenment period is still preferred to blind faith, superstition, and other unfamiliar ways of thinking. This is happening probably because of the 'benefits' brought by World Modern Science to human life, which include also the problems that we are facing with climate change and the effects of the atomic bombings of Hiroshima and Nagasaki.

In the field of educational research the preference for the ideas established in the Enlightenment period is shown by positivist researchers' view that qualitative research, which includes points of view, lacks rigour as it is always embedded or situated in the author's context and the researcher could also be female. "To be embedded is to be immersed in relationships and connections that interfere with the rigor (and purity of vision) ostensibly required of empirical science" (Greene, 1994, p. 433).

Dewey was among those who refused the universalism of World Modern Science, and created a basis for research such as auto/ethnography through his refusal to see the world as one-sided. Dewey and other philosophers have justified that:

> … educational researchers who study classrooms or the realities of supervision must take into account the meanings of what happens as articulated by the students, teachers, administrators, all who are involved. All this connects not only with what we now view as qualitative research but with what we now recognize as constructed reality. (Greene, 1994, p. 434)

Critiques of the independent observer (Roth, 2005) can also be found in European phenomenology and existential and critical hermeneutic philosophy, which claim that the knower should be unified with phenomena in order to grasp and understand them. Hence the justification of my knowledge claims from this study are associated with my union (Breuer, 2005) with the phenomena that I am studying, especially my view of education and its cultural context. At least two factors are influencing my claims:

(1) my history of (a) learning and teaching and (b) being enculturated in my own culture and acculturated/assimilated (see Glossary) in several other cultures that exist in Mozambique; and

(2) (a) my studies and readings at Curtin University of Technology – Science and Mathematics Education Centre (SMEC), (b) my interaction with colleagues from different backgrounds who are analysing their own culture, and (c) being enculturated into non – positivist research paradigms. I have attempted to give an account of these factors so the reader can understand my claims through my perspective; that is, I am inviting you, the reader, to be a connected knower.

My standpoint shown by my adoption of critical auto/ethnography is that it is the meaning of my experiences of learning and teaching World Modern Science that constitute reality and not the ontological characteristic of that experience. My experience is a clamour for integrating many existing ways of knowing.

> There are ways of knowing characterizing daily life; there are others peculiar to the worlds of the natural sciences, the social sciences, the arts, religion, play, even dreams. Each one provides a perspective on the lived world, a distinctive mode of directing attention to the reality shared with others. (Greene, 1994, p. 436)

The different ways of knowing encompass different degrees of subjectivity and objectivity. In this view the knower is intellectually and emotionally or physically and spiritually involved in the research with the aim to understand the world, including self education, and not to control the world. In this way I am refusing the positivist and depersonalized standpoints in relation to World Modern Science and its consequence of separating body and mind and subject and object.

> A total, exterior viewing (a "view from nowhere," for example) is inconceivable. Because the structures of knowledge themselves are always founded in layers on the perceived landscape, absolute knowledge is impossible. We are all (women and men, those of us at the margins and those of us at the center) temporal beings and live in time. (Greene, 1994, p. 437)

I believe that I have justified the trustworthiness (epistemology) of my research. My concern now is to show how the findings from different sources in my research are legitimised and how the readers should understand how I have applied my quality standards. My initial thoughts and experience indicated that it could be done by the researcher including triangulation in his study. Hence, I asked myself, to what extent is triangulation involved in my method?

Quality Standards

Discovering crystallization

In this section I am presenting how I have discovered the overarching quality standard of 'crystallization' and how the need to apply other quality standards led me to comprehending them. I discovered crystallization in the process of selecting the quality standards that are applicable to my research in which I have assumed that the research is acceptable not only because it is based on my life and working experience but, first and foremost, because of the human experiences portrayed here. I have assumed also that:

(1) this study is limited by my experience and context. These are undoubtedly not the same for every professional in science education. The study represents a contribution to those who have similar experiences in context, and for those who can relate to my situation in one or other way;

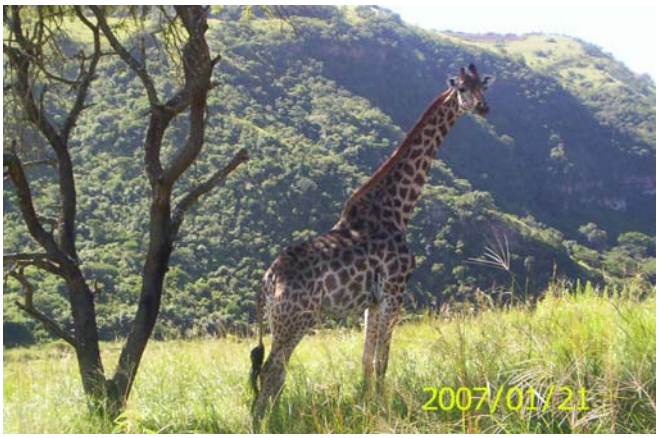

Figure 2.6. Each point of view has its limitation and advantageous.

(2) I have analysed science education in Mozambique from different perspectives that do not necessarily converge.

The process of determining the quality standards that are applicable to my research constitute one of the biggest challenges that I faced in this work. It constituted another challenge to my positivist view of research in which one of the main quality standards is triangulation that can assume many forms. The main characteristic of triangulation is that the researcher should end up at a convergent point or explain why that point was not reached. Hence, the replication of the study should produce the similar results.

The use of auto/ethnography was, I think, the right choice, because the research does not inhibit other researchers from doing similar studies and from reaching different conclusions. Instead it is an invitation for Mozambicans to also give their contribution; together, we can decide what values and philosophy are desirable for Mozambique.

I assimilated a long time ago and repeated for many years, for example, the notion that 'triangulation' is one of the strongest criteria for validating educational research. So my quest was how to apply triangulation in such a way that fitted with my new qualitative vision of research. My reading about triangulation showed that it was (is) used widely in qualitative research. This made me feel

happy and I was in peace of mind until I was asked ‘why triangulate and not crystallize?’ by my mentor.

This question made me move from my comfort zone and face the problem that was eluding me: how to apply the quality standards of qualitative research to my inquiry. This section shows how I have responded to that problem.

Initially triangulation (Mathison, 1988) was perceived as the requirement to have validity in qualitative research. According to this view, triangulation plays two roles. One role is to show that the same results can be found using other methods or measurements, or at least that different results do not contradict each other. The second role is to eliminate bias in the research process. This stand is problematic because different methods, in general, address different aspects of the same social phenomenon and the juxtaposition of methods by itself does not necessarily eliminate bias.

Data triangulation is understood as the use of several data sources, “the obvious example being the inclusion of more than one individual as a source of data” (Mathison, 1988, p.14). In my study I act sometimes as a researcher and other times as the source of data. Furthermore, I interviewed three colleagues and I analysed Mozambican educational documents to collect data. This notion of triangulation includes time and space in order to make sure that the conclusions are not related only to a nodal moment of the social phenomenon being studied. In my study, the components of time and space in the notion of data triangulation explained by Denzin (1989) are defined by my inclusion as a source of data over the period that I analysed my experience of teaching. My problem in considering if my procedure is data triangulation arises because I did not seek to obtain convergent views of the Mozambican education process but, rather, different understandings of it. I did not try to necessarily make the different understandings convergent.

Methodological triangulation means to use different methods. The main advantage of combining methods in a triangulation sense is that the methods can be chosen in the way that each of them covers the weaknesses of the other in portraying the unique and desired Truth in science education. My problem is that

my concern is not to uncover **the** Truth but 'a truth', indeed multiple truths. One negative aspect of searching for **the** Truth is that the owner of that Truth tries to impose it on others as it happened, and probably is still happening in Mozambique with the teaching of a single view of the world through World Modern Science.

> I am thinking that World Modern Science was imposed 'in good faith' - that proponents are proposing a valid way of obtaining **the** Truth; that different religions exclude each other; and that each one of the political groups tries to survive at the expense of others - they pretend to have the True way of living. But the act of searching for Truth, for me, expresses the intention to dominate others.

Miles and Huberman (1994) support my view that to reconcile different findings from triangulation drives the researcher to problems that cannot be solved. Hence, they propose to concentrate on the process instead of the findings. "If you self-consciously set out to collect and double-check findings, using multiple sources and modes of evidence, the verification process will largely be built into data collection as you go" (p. 267). However, they add that, in effect, triangulation is a way to get to the findings in the first place – "by seeing multiple *instances* of it from different *sources* by using different *methods* and by squaring the finding with others it needs to be squared with" (p. 267).

Miles and Huberman's (1994) point of view can be understood this way: the data analyses from different approaches do not necessarily need to be convergent. Sometimes, the analyses can be inconsistent or contradictory and the researcher's role is to explain the incongruity. This makes the problem of finding 'the Truth' via 'triangulation' inadequate for my research, as I do not see myself as a colonizer substitute whose aim is to substitute the unique view of the world obtained through World Modern Science with so-called indigenous knowledge, for example. Therefore how do I convince you, my reader, that my different findings from different sources are legitimate?

I have generated my data based on my (re)created experience, the view of my former students about my and their teaching experiences (initially I thought that we could concentrate only on my teaching) and Mozambican policy documents. The three sources provided three different kinds of data that I do not

think deserve necessarily to be made convergent. My stories show that alienation in our identity is one of the major causes of having education that is not relevant for everyday life in Mozambique (see Chapter Four); my former students indicated that conditions offered to educators in schools today do not allow them to reflect on what they are doing (see Chapter Two); and the newer policy documents are an attempt to officially introduce 'local-indigenous curriculum'. Hence, the data generated using different methods do not need to be triangulated in order to converge, because they represent different perspectives needed to be exploited to improve the Mozambican education system.

My rejection of triangulation to be used as an overarching quality standard in my research brought Peter, my mentor, to suggest 'Crystallization' as being more adequate. He recommended I read 'Writing: A method of inquiry' by Richardson and St. Pierre (2005).

Crystallization: An overarching quality standard

Figure 2.7. The crystal receives light from several directions that is scattered, bended, cracked and can be reflected into a kaleidoscope of many optical phenomena.

The title, 'Writing: A method of inquiry', by Richardson and St. Pierre (2005) is intriguing because it challenged my view about writing and about writing being a method of inquiry. It looked trivial and I could not figure out how a special writing could exist that would be considered a method of inquiry. Furthermore, I was eager to know if my writing fits with the authors' view. Finally, how is crystallization a better criterion than triangulation?

My writing is a method of inquiry (Richardson & St. Pierre, 2005) for a number of reasons. One of these reasons is that the inquiry develops as the writing

proceeds and does not simply obey a pre-established plan such as what happens usually in traditional scientific writing where “writers wrote in the homogenized voice of [World Modern Science]” (p. 960).

Second, my writing is a method of inquiry because I have embraced a qualitative study in which I am researcher and participant (Luitel & Taylor, 2005, Apr; Song & Taylor, 2005). By being researcher and participant allows me to understand the educational process and me as being in a dialectical relationship. What philosophy and values have been guiding the education system in Mozambique? To what extent have I been formed by this philosophy and values? To what extent have I assumed and implemented this philosophy and these values? What are my values and philosophy? Which philosophy and values would I like to see guiding the education system in Mozambique and in my life? Hence, I am writing in a context; whereas scientific writing, for example, does not allow the writer to inquire about his/her values or, in other words, to learn about him/herself.

My reading of Richardson and St. Pierre (2005) is that language determines the understanding of myself and of the education process that I am investigating. My view is that language determines not only that understanding but also the reader’s background in an intrinsic way.

Richardson and St. Pierre (2005) affirm that texts are imbued with values. Indeed, texts are imbued (consciously or not) by the writer’s values developed before and during the writing process. The inclusion of these values is, in our postmodern era, probably facilitated because of the coexistence of various genres of writing, which is more diverse than the writing of the 17th Century. One of the shared values in the postmodern era is the recognition of the limitation of the writer to their own context. The values that drive writers form systems of reasoning and one of these systems in the postmodern era is ‘poststructuralism’ that invites you and me as writers to:

> …understand ourselves reflexively as persons writing from particular positions at specific times. Second, it frees us from trying to write a single text in which everything is said at once to everyone. Nurturing our own voices releases the censorious hold of “science writing” on our consciousness as well as the arrogance it fosters in our psyche;

> writing is validated as a method of knowing. (Richardson & St. Pierre, 2005, p. 962)

Although it is clear that the writer's individuality is always present in every piece of work, it should be noted that only part of this individuality is expressed. Accordingly, it cannot be evaluated by triangulation because it contains more than two perspectives; hence, these writers do not triangulate but crystallise. Like crystals, we reflect on our inner landscape, our environment "creating different colours, patterns, and arrays casting off in different directions. What we see depends on our angle of repose – not triangulation but rather crystallization" (Richardson & St. Pierre, 2005, p. 963).

My quality standards

Crystallization explains why I was reluctant to merge my findings from different sources. Each group of my findings stands from its own perspective as I have analysed the Mozambican education process. Does this mean that the findings are acceptable *prima facie* or are there quality standards that can be applied? Six quality standards, besides crystallization, are suitable for my thesis: (1) *Substantive contribution and Verisimilitude*, (2) *Ironic validity*, (3) *Aesthetic merit*, (4) *Critical reflexivity*, (5) *Pedagogical thoughtfulness and* (6) *Vulnerability*.

(1) *Substantive contribution and Verisimilitude*. My research meets the *Substantive contribution* (Richardson & St. Pierre, 2005) quality standard as it makes a substantial contribution towards readers' understanding of Mozambican social life, perspectives, changes and dilemmas, especially the Mozambican education process. This quality criterion is shown in my thesis mainly by my stories and their interpretive comments about my life and the Mozambican science classroom. They are aimed at allowing the reader to reach a rich understanding of Mozambican science education and to support my proposal to change the way it has been and where it might go. The reader's acceptance of my description of social reality without questioning its credibility is another quality standard called *verisimilitude* (Geelan, 2007; Richardson, 2000); in other words my writing seems to describe a 'real' world.

(2) *Ironic validity* (Geelan, 2007; Lather & Smithies, 1997). This quality standard can be applied to this research as I have represented the lived situation in Mozambique in various ways, showing the advantages and limitations of our situation in each way. In other words, I have also included in this thesis evidence that does not support my claims (disconfirming evidence) which, instead of making my thesis weak, ironically makes it strong.

Ironic validity is my way of acknowledging the crisis of representation that we are living in, meaning that there is no essentialist (pure) representation for Mozambicans (see Chapter Four). My text should be understood also as an effort to represent my understanding of Mozambican life and science education in Mozambique, that an understanding that cannot be fully reached; thus, it constitutes an ironic representation. Therefore, it is unthinkable for me to try to represent what Mozambican life and science education is or should be for everyone. However, ironically, by writing this text I have learnt a lot about Mozambican life, science education in Mozambique and me. I hope that (I should say this is my aim) the reader will understand some of the problems that we are facing in Mozambique and will apply my suggestions in his/her setting according to his/her background (Cunningham, 1997; Lather, 1993).

One of Mozambique's problems is the inadequacy of its teaching a single view of science. I have used *ironic validity* to make the point that World Modern Science should not be eliminated from the Mozambican science classroom but integrated with others' sciences.

(3) *Aesthetic merit* or *Poesis* (Henderson & Kesson, 2004; Richardson & St. Pierre, 2005) is the quality standard that combines skills and beauty. Aesthetic merit is shown by the organisation of my thesis. The values that I brought to this research and other values that I have constructed during the research are included. Included also are the values of my people. From my standpoint, through this research, I do not see any harm that can result. Indeed, my research can help many people, especially Mozambicans to alleviate the pain of living in two sometimes contradictory worlds without understanding the origin of their anxieties.

My preoccupation during this research was not only to do well but also to achieve perfection and not to do harm. My readers will decide if I have achieved this quality standard by looking at my way of addressing axiology or, in other words, how I make this research valuable for me, other educational researchers and Mozambique in general. Axiology is related to *ethics* and *aesthetics* in the sense that they focus on how we act in the world. I have used axiology to generate my data according to my ontological and epistemological understanding of the knowledge (Ruona & Lynham, 2004).

From an *ethical* perspective this research should be sensitive to the values and customs that I have and those that exist in my society. An ethical issue considered in this study is 'informed consent' of the participants. The definition of informed consent is given by Cohen et al. (2000) as the decision made by participants after they have all the knowledge that can influence their decision to participate. 'Confidentiality' is another crucial ethical factor which ensures that the identity of participants will not be revealed in any way. Aliases were used instead of their actual names. The last ethical issue is related to my self-study. (a) The reader will be able to distinguish between my analysis and the story that I am analysing and (b) I have avoided being narcissist by exposing what I understood as our Mozambican common experience. In other words I have avoided my self-harm through this research.

I could not find the supporting literature for the notion of self-harm in qualitative studies. Indeed what I found is that I do not have control of my readers' interpretation which can perhaps result in pain for me (Ellis, 1999). The vast literature that describes the care needed to avoid harm to participants (Cannella & Lincoln, 2007; Ellis, 2007; Fisher, 2007) made me question the desirability of the ethics of self care. My stand is that the ethics of self care are inherent to auto/ethnography studies such as I am presenting here because the final aim of these studies is to justify emancipation in culture and society. This is why I exposed here my interpretation of what happened (is happening) to Mozambican people including me.

The *aesthetic* dimension gives a sense of harmony to the entire thesis. In considering the *aesthetic merit* or *Poesis* of my thesis the reader(s) should contemplate the following questions: (a) Does this thesis invite the reader to have

multiple interpretations? and (b) “Is the text artistically shaped, satisfying, complex, and not boring?” (Richardson & St. Pierre, 2005, p. 964)

Multiple interpretations means that the reader will be able to acknowledge my standpoint that our shared experience of Mozambican life and science education is seen differently by each of us according to our ethnic group, sex, gender, age and identity. Our subculture should be treated with respect and honour but cannot be seen as the norm for the entire society. This standpoint is called *Dialogos* by Henderson and Kesson (2004).

Figure 2.8. Aesthetic is also part of our inner life.

I have included another two dimensions to the *aesthetic merit* of this thesis; they are *impressionistic* (Maanen, 1988) and *evocative* (Ellis, 1997) quality standards. The impressionistic quality standard intends to give the reader my understanding of what is currently happening in Mozambique, especially in the field of science education, in such a way that they feel how that reality has impacted on me. My intention is to make the reader ‘live’ my experience of being Mozambican and being enculturated in World Modern Science to the extent that I became a promulgator. Impressionism in this thesis manifests as a dramatic dimension, understood as my intention to capture my readers’ attention about the need for

transformative action: hence the evocative (Ellis, 1997) quality standards that will be evidenced by the reader's understanding of, on the one hand, the need to transform science teaching and teacher education in Mozambique and, on the other hand, the need to contribute to more sustainable education in his/her setting.

(4) *Critical reflexivity* (Brookfield, 1995). This quality standard sometimes called 'Critical Thinking' is linked to the emancipatory interest because it questions accepted codes of conduct that determine an individual's interior and exterior reactions and interactions among people. It allowed me to expose myself to my readers. My aim is for the readers to comprehend my self-critical process of constructing my standpoints and of not being a narcissist. At the beginning I knew who I was but when I was asked 'What does it mean to be a Mozambican?' the answer did not come easily. I started to reflect on myself and my people. At some stages of my research I thought that I had found the answer. I was sure about what it means to be Mozambican, but in the next stage I lost this certainty again. In the process, I have built a consciousness of being Mozambican, at peace with my situation, of living in a traditional and modern world and of being independent and carrying many colonial values.

I am using critical thinking in this research to seek for a Mozambican way of living and teaching science. This search is contextualised in three ways. (I) Mozambique becoming independent from Portugal (the colonial power) and experiencing many transformations after independence including the attempt to kill the tribal nature of the people in order to give birth to the nation, and natural calamities. (II) Ethnic groups not being restricted to their geographical places of origin and not having any local-indigenous language that could be used throughout the country other than the colonial language of Portuguese. For example, Changana, which was originally found in Gaza province (one of Mozambique's 11 provinces) and now can be found in the entire country, but is mainly restricted to that ethnic group. This is true also for Macua, Maconde and other ethnic groups in Mozambique. (III) Teaching science in the same way that was taught during the colonial era. To me this shows the continuing hegemony of the colonial power. We have been enculturated in such a way that 'science' has a singular and distinct meaning created by the colonial power in Mozambique. The

fact that that World Modern Science is taught all over the world, including places that never experienced colonial power, does not negate the view that World Modern Science conveys colonial values: colonialists also colonize themselves. Teaching science, then, in the same way that was taught in the colonial era suggests a way of living that we negated when we fought for our independence.

The critical analysis of my life and professional practice was based on my stories of lived experience as a Mozambican and on my reflections, observations, and experience of being a learner, teacher and science teacher educator in Mozambique. This is called by Brookfield (Richardson & St. Pierre, 2005) the four lenses: autobiographical experience, students' perceptions of our way of being and teaching, colleagues' perceptions and experience, and the literature on educational practices.

(5) *Pedagogical thoughtfulness*. My research should impact on readers' (Taylor & Settlemaier, 2003; Van Manen, 1991) feelings and reactions. One of these impacts is *pedagogical thoughtfulness* (Mutua & Swadener, 2004; Tierney, 2000). This quality standard is met when the research emotionally/intellectually influences the reader in such a way that s/he feels like a vulnerable observer who is impelled to ask questions or take other action. A good critical auto/ethnography creates a reader's passion to act. The action does not necessarily need to be 'visible' but can be a reinforcement of principles of equity/justice or a commitment to have a meaningful education. My wish is to provoke inclusive participation in the science teaching process, especially from science teachers.

(6) *Vulnerability*. I have exposed myself by showing my beliefs, uncertainties and emotions. I hope that people who finish reading this thesis will know who I am, what I believe in, and my values. In this way, through this research, I have become v*ulnerable*. Vulnerability contributes to decolonization (Bilton et al., 2002, p. 58); hence this research contributed also to freeing myself from many hegemonic forces currently guiding our lives in Mozambique. In this research I have made myself vulnerable because I wanted to engage you, my reader, in a search for better ways of living. My understanding of decolonization is strongly influenced by being a Black man; born in Africa (Mozambique), a

country that was under colonialism for nearly 500 years; and who experienced some years of that colonialism.

My intention in this remaining section of vulnerability quality standards is to show how my self esteem (personality) was lowered by colonial policy and other related factors that made me vulnerable in the colonial environment. In other words, I am portraying how colonialism is another dimension of my vulnerability. The colonization of some countries by Western countries contributed to the development of the West, to the formation of modern societies, and to the appearance of modernism all over the world. One consequence of colonialism was the demolition and/or transformation of societies and cultures that clashed with Western power.

Figure 2.9. In this thesis, I have exposed my understanding, using among others' quality standards of 'vulnerability'.

The world, including Western countries, witnessed the appearance of a secularisation[4] process characterised by faith in a secular way of thinking, such as World Modern Science, **T**ruth and progress. This colonization is consequently a

[4] Not concerned with religion

cultural imperialism based on the assumption that "its value system is superior and preferable to those of non-Western cultures" (Machel, 1985). I perceive colonialism as a system degrading to human beings. According to Samora Machel (1985) colonialism means:

> … exploitation, oppression, humiliation, social and economic discrimination, racism, tribalism, and regionalism, [in other words] bribery, corruption, and immorality; robbery; nepotism, favouritism and patronage; individualism and ambition; servility and subservience; prostitution; vagrancy; banditry; unemployment and delinquency; begging; orgies; bacchanalia and drunkenness; drugs; destruction of family; social disruption, insecurity and fear. (p. 89)

The readers may wonder how all these bad things can be attributed to colonialism. I see two reasons: firstly, all those awful things were exacerbated during the colonial time and, secondly, the word 'colonialism' possibly directs the reader's mind to colonizers, but the statement characterizes 'colonialism' by what was happening, without mentioning the protagonists. I witnessed both colonizers and colonized people practising those inequalities. Maybe this explains why the colonized tends to reject his own people (culture).

Fanon (1967) affirmed that the stage of colonialism where colonizers and colonized are rejecting the local-indigenous ways of living is a signifier that native systems have been destroyed.

> Having witnessed the liquidation of its systems of reference, the collapse of its cultural patterns, the native can only recognize with the occupant that "God is not on his side" The oppressor, through the inclusive and frightening character of his authority, manages to impose on the native new ways of seeing, and in particular a pejorative judgement with respect to his original forms of existing. (p. 39)

This is called 'alienation'. Colonizers would like assimilation but there is a restraint in terms of how far the native population can be allowed to evolve. In the colonizers' mind, natives should evolve to a certain level but not to the colonizers' level. Natives coerced by the colonial force and context have to admit that their adversity results directly from their racial and cultural characteristics. Hence we

(natives) feel guilt and inferior, and try to escape those bad feelings "on the one hand by proclaiming his total and unconditional adoption of the new cultural models, and on the other, by pronouncing a condemnation of his cultural style" (Bullough & Pinnegar, 2001). In this setting, natives are left with little choice other than to acquire colonial values, which run in the face of their cultural traditions and mores, as a means to escape from the situation in which they exist.

I understand that to be decolonized is to embrace the ethic of care that I have expressed in the following poem called *My Life*.

My Life

I was unexpected
I am a third born
I am a boy preceded by two girls
My mother on the day that I was born said she expected a girl not a boy
Even my mother did not expect me
I am unexpected

Is my life expected?
Are the events in my life expected?
Are my willing reactions, attitudes and actions expected?
Are my relationships expected?
Do I know who I am?

I am a third born
'Third' means 'many'
I have many willing reactions, attitudes and actions
I have learnt many sciences (Western, African and Asian) including mine called 'indigenous'
I have been teaching many people
I have many relationships
I am having a relationship with you.

Where are you?
Are you (a)part of me?
Are my willing reactions, attitudes and actions (a)part of me?
Who is determining events in my life?
Are you the one who determines events in my life?
Am I the one who determines events in my life?
You and I determine events in my life.
You are me.

We are sharing the same space, air, time
We are sharing the same destiny and characteristics
We are characterized by the same emotions, anxieties and aspirations
Yet we are different
There is you, and
There is me

Who are you?
Is your life ordered?
Are events in your life sequential and smooth?
Are things happening according to your wishes?
Is your life predictable as an event in World Modern Science?

We are two faces of the same coin
We are blocks of the same wall
We are part of a human mosaic
Without you or me the human mosaic is incomplete
You are me
The human mosaic doesn't have form, structure, configuration …
The human mosaic is you and me.

Cupane, June 2007.

This poem shows that we will achieve decolonization when we develop the quality of mutual caring. Until now our behaviour shows in many cases that we perceive the existence of other members of our society simply as a means of achieving the colonizer status. But how can that occur if the colonizers were expelled more than 30 years ago? It is true! However, they left us a legacy of not seeing our fellow human beings as having equal value and status (the colonizers were never part of us, they were something superior and intangible), and hence we are now trying to be superior to other Mozambicans.

This is the manifestation of the mentality of 'dependence' inculcated in us by the colonial power. Indeed, most of the time, our well-being was dependent on the colonizer(s) being included in our relationships. We see ourselves always as dependent on status, money, technology and relationships. I know the importance of those things and the extent to which they determine the quality of our lives. My point is that our way of behaving shows that we see our own lives as dependent on our 'status' or how others regard us. I would like to free myself from this mentality and contribute to the freedom of my people, especially my students.

My wish to contribute to the freedom of my students makes me question the way that I have been teaching which is my first specific research question. In that question I am looking at how I have included my culture in my teaching; consequently, a research question emerges: what are the values promoted by my culture? I come back to this question in Chapter Five.

Summary of The Chapter

I have characterized in this chapter the auto/ethnographic method that I am using in this thesis which focuses simultaneously on the individual (me) and the societal (all the influences to which I have been exposed). I have argued that my aim is not to describe all the events that have occurred in my life but to use nodal moments to understand key aspects of Mozambican cultural life, especially in the field of science education. I am moved by the perception in my life and teaching experience that, although we are independent and have a clear policy of promoting our culture, our actions perpetuate sometimes the inequalities, myths, and hegemonic forces that have driven our cultural life, including the education process, in Mozambique.

The partial outcomes of this chapter are my understanding that I am studying myself and the science education process that occurs in Mozambique from my perspective (postmodernism), and to understand better that the same process requires as much study as possible. This study is not a rearrangement of Mozambican social reality (poststructuralism). In this study, I am making an effort to understand myself and others as connected knowers (critical hermeneutics) and I do not pretend that we (Mozambicans) are perfect and that we are just victims of colonialism (feminism).

Figure 2.10. Husband.

Figure 2.11. Father.

Figure 2.12. Educator, Mozambican, African, European, world citizen.

I am using seven quality standards including the overarching one that is crystallization. The others are substantive contribution and verisimilitude, ironic validity, aesthetic merit, critical reflexivity, pedagogical thoughtfulness and vulnerability that will be used to analyse the extent to which I have met the objectives that I have proposed for myself. One of my objectives was to evaluate (culturally) my earlier teaching before commencing this research. My hope is that one of the outcomes from the next chapter (Chapter Three) will be that my culture is always with me in different aspects of my life such as those illustrated in Figures 2.10, 2.11 and 2.12.

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Chapter Three: Critical Reflection on my Science Teacher Educator Practice (1994-2001)

Introduction

> A Educação é um direito básico e um instrumento fundamental para o desenvolvimento do capital humano, condição necessária para a redução da probreza em Moçambique. É um processo dinâmico, através do qual a sociedade prepara as novas gerações para dar continuidade ao processo de desenvolvimento[1] (Cultura & Educação, 2006)

Figure 3.1. Is enculturation included in the teaching process in Mozambique?

My concern in this chapter is to reflect critically on the extent to which my culture has been part of my earlier teaching. I have justified this concern in Chapter One where I emphasised that to become a good teacher moved me to do this research and how, at the start of my research, questions emerged that I am now answering using critical auto/ethnography (Chapter Two).

In 1994 after finishing my degree in teaching science and mathematics I was invited to join my lecturers and become a science teacher educator. At that time I did not have an opportunity to reflect on how I had been teaching science and mathematics and in what way I should help my student-teachers to find their own way of teaching. Today I am amazed at the realisation that I thought my

[1] My translation of the quote above is: Education is a basic right and a fundamental instrument for the development of human capital, which is essential to reduce poverty in Mozambique. Education is a dynamic process used by society to prepare new generations to continue the development process.

student-teachers should replicate my way of teaching. Could I think differently? Was I not myself replicating the way of teaching expressed by my teachers in their science classrooms?

The scope of how I used to teach science and mathematics and its impact on my teaching practice constitute the specific research question 1 (What are the culture-sensitive teaching/learning strategies that have been shaping my praxis? How effective have they been?) that I am reflecting on in this chapter. My role as science and mathematic teacher and science teacher educator implies that while examining my experience I am simultaneously examining science and mathematics education in Mozambique (Chapter Two).

I have decided that the first step to answering my research question will be to write about myself and my work as I wish to provide a 'picture' of science education in Mozambique. This is challenging because I have to let the reader know what I have been doing and how I understand myself then and now at a point when my doctoral research has not produced new ways of analysing and improving my teaching. It is a disclosure of how I am part of the problem and part of the solution in the field of education in Mozambique. This disclosure should be evaluated using two criteria. The first criterion is the extent to which the chapter appeals to the reader to act to improve her/his life and the life of other people, especially in the field of education. The second criterion involves deciding how realistic is the proposal made in this thesis for improving the Mozambican education system by embracing strategies and content that can allow each of our students to be educated according to his or her condition, needs and environment. In this way, my disclosure aims to contribute to the transformation of curriculum into 'curriculum wisdom' (Henderson & Kesson, 2004).

I am aware that I cannot describe my entire experience of teaching and learning. I would like to describe all my feelings and desires in the field of education but it seems impossible. My problem can be seen by using the fish in water analogy: the fish is not aware of the water but even if we manage to call the fish's attention to the water it will just see the water in front of its eyes and not all the water around it. Here, everyone will agree that the sample of water is very

small for each fish to conclude about the overall quality of the water; however, if many fish combine their small samples they can reach a sound conclusion about the water quality. This is what drove me to include my colleagues' views and former student-teachers in this thesis.

My aim is not to dwell on myself, my colleagues and former student-teachers but to reflect on my experience as a means of arguing for the inclusion of Mozambican culture; the trustworthiness of this experience is that it was acquired in interactions with other Mozambicans. Hence, I would like you, my reader, to understand this chapter not as a general description and solution of Mozambique's problems in the field of education but as providing perspectives on how Mozambicans can transform our education system. How does this differ from 'a general description and solution of Mozambique's problems?' My understanding is that this is just one way of seeing those problems and it is necessarily incomplete.

This chapter focuses on my experience of being a teacher in Mozambique. I reflect on my experience of teaching using a social constructivist perspective on teaching and learning, one of the theories that I acquired in my Masters Degree. In my analysis I am considering the inclusion of my Mozambican culture in my previous teaching. I am presenting this experience partially heartened by the fact that my colleagues confirmed (see Appendix A: Science Teaching in Mozambique) what I think about education in Mozambique and partially moved by the wish to illustrate what I meant by examining the perspectives of my colleagues. This chapter and the referred appendix represent the way that World Modern Science (see Chapter One) is taught in many Mozambican schools, a way that I aim to change because my interest in cultural inclusiveness is not being served by that way of teaching.

For constructivism, learning is influenced by the prior knowledge that students bring to the process of learning. It is also influenced by the local culture. In this process students construct their knowledge, which means that they are discovering new ways of explaining phenomena or doing things. This is what is advocated by a personal constructivist view. From this perspective, new ways of

seeing the world "occur when a student personally finds that science conceptions are more intelligible, plausible, and fruitful than his/her own previously held conceptions" (Cobern, 1993, p. 54). Contextual or social constructivism is a natural outgrowth of personal constructivism. The social constructivist view of science education tries to maintain balance between the interactions of cultures in the classroom and between the needs of change and maintenance of societal structure where it is applied.

Social constructivism does not accept the theory that non-World Modern Science ideas are irrational based on the assumption that scientific 'Westerner' thinking is the ultimate measure of rationality. This implies that a given phenomenon can be explained in various ways. "People do not believe things that do not make sense. They believe precisely because sense is being made – because there is rationality" (Cobern, 1998, p. 17). Hence, in teaching science, instead of having in mind that science is only a necessary component of advanced technology, important for economic development, it is also necessary to think that there is more than economic growth that can make people interested in science. As Cobern (1998) reminds us, Jesus of Nazareth was expressing the same idea when He said *Man does not live by bread alone* (p. 20). The question is: whose interests are being served by science education? (Taylor & Cobern, 1998). These authors suggested that social constructivism "in combination with other theoretical frameworks, can serve a variety of critical social standpoints which illuminate, in complex, intriguing and provocative ways, the various cultural contexts within which both science and students of science are embedded" (p. 203).

My experience of teaching that is presented in detail in this chapter is contrasted with the perspectives of my former student-teachers and includes my analysis of the extent to which my experiences include culture sensitivity. Having in mind that one's teaching value is not fully measurable I end this chapter by questioning my previous teaching in which I employed the 'Locally Available Materials Technique'.

I became aware of the concept of 'Locally Available Materials Technique' experiments when I was lecturing in Physics Didactic at Pedagogical University with Professor Barbara Gau, an enthusiastic advocate of the usage of this pedagogical approach. Between 1997 and 2000 Professor Gau disseminated this concept among student-teachers, lecturers, teachers and students at high school. In almost all lectures, Professor Gau included something involving the Locally Available Materials Technique. In simulated lessons, student-teachers were encouraged to find ways to stimulate students' activities, collecting and bringing everyday material for this purpose.

Each year the class prepared a special day in a school in the city or countryside of Maputo province, called Physics Day, in which our student-teachers gave demonstrations of how the teaching and learning process could occur if locally available materials were included. The main goal was to show that, in a social constructivist (after my Masters Degree I can use this term) way of teaching, students and their background can be at the centre of the education process.

Therefore, everyday material was involved as much as possible, such as candles, mirrors, tins, wooden sticks, and so on. In this way Professor Gau was demonstrating that it is possible to teach using the Locally Available Materials Technique. I was convinced that this approach was useful because it advocated that personal experience is necessary in order to learn and students are likely to make sense of what has been taught if that can be related to their lives. My enthusiasm while working with Professor Gau was that the technique could help in the Mozambican context where educational technology is not well funded. My Masters Degree made clear that this technique alone is not enough for this purpose, and hence the continuation of my studies to understand the human dimension (that can be brought out by my introspection) involved in the teaching process in Mozambique.

The outcomes from this chapter are twofold. The first outcome is the confirmation by my former student-teachers of my understanding of my teaching, and the second is my analysis of their (non)use of the Locally Available Materials

Technique in their current teaching. Although I cannot say that I am happy with their usage of the Locally Available Materials Technique, in the future I shall continue to use this approach because I would like student-teachers to have a clear understanding of World Modern Science (see Chapter One) in its own terms. My wish is supported by many authors (Gerdes, 1998, 2003; Struik, 2003; Winter, 2007) who have shown that the basis of World Modern Science can be found in different cultures and locations.

Figure 3.2. How many ontologies and epistemologies are contained in this Aboriginal picture?

The View of My Teaching by My Former Student-Teachers

My hope was that I and my former student-teachers have a similar view about my teaching. Interviewing them was a way of enriching the description of my teaching experience. However, in the analysis of the interviews, I discovered that my former student-teachers had a different view of my teaching; more importantly their view about my teaching was being replaced by the experience of teaching that they were accumulating. In this way, my attempt to describe my experience of teaching was expanded from a personal experience to a multifaceted view of Mozambican educational reality by my former student-teachers and I.

I interviewed my former student-teachers from 12 May and 09 July 2005 in Maputo, based on the story below titled ‘Is there any ‘best way’ of teaching?’ During the interview I asked if they agreed with the ‘reality’ of my story, about

the advantages and disadvantages of the methods that I used during their time as my student-teachers, and if they were using similar teaching methods now, especially the Locally Available Materials Technique, and if so, why? (see Appendix D for details).

Is there any 'best way' of teaching?

Cupane was at an earlier stage of his career as a physics and mathematics teacher educator, at the transition between being a student-teacher and lecturer. He believed in the potential of human beings to promote changes and he dreamed of a better world. He saw himself as contributing to the changes occurring in the world in his small physics classroom.

Cupane's main goal was to connect the student-teachers' lives with his teaching. The reason for this was to provide a model for these teachers to do the same with their students. Therefore, he discussed with his student-teachers how he would apply examples, problems and materials used in their everyday lives in physics teaching.

Cupane believed that, without this connection, the learning process was not possible. This was the inspiration for his teaching. It was, on the one hand, a way of solving the problem of lack of teaching materials and, on the other hand, a way of adopting teaching strategies that involved students' every day materials.

Praxis was another requirement Cupane believed was important for learning to happen. By having student-teachers reflect on their actions, he asked student-teachers to do a simulation of their role as teachers. They were also expected to do a lot of experiments in the laboratory. These simulations were followed by a debate guided by two points: identifying the positive aspects in the simulated lesson and describing what could be improved. The first student-teacher to participate in the debate was the one who was acting as teacher. Cupane asked himself many times whether student-teachers 'really' understood what they were doing. Could they apply this understanding to their lives and profession? Did they really think about what they were doing?

The Interview Process

My participants were eight former student-teachers from Pedagogical University in Maputo (see Table 3.1 for details). I did not directly select these participants; I found them through my colleagues who helped me to locate them in a variety of schools in Maputo.

Table 3.1. The participants in interviews related to my teaching.

	Teachers' Aliases	Grade taught by teacher	Chapters in the unit
1	C Francisco	Year 11 and 12	5
2	A Nazare	Year 9 and 11	7
3	P Instrumento	Year 8, 9, 10	4
4	E Comida	Year 10	5
5	T Stocks	Year 10	-
6	Tilu	Year 11 and 12	6
7	Dala	Year 10 and 11	5
8	Casimiro	Year 9 and 10	7

My procedure with each of the participants was to explain that I would like to recall my teaching through their eyes. I asked them to read the story and respond to the questions I had prepared (see Appendix D). We then agreed on the date I would collect their responses. When I collected their responses I asked for their comments about their responses. My former student-teachers agreed that my story closely represents the way that I used to teach them. None of them added or modified any details of the story. A representative response in relation to how I used to teach comes from Casimiro.

My initial intention was to analyse my own teaching but the conversations with my former student-teachers pushed me to also try to understand their personal teaching challenges. Casimiro graduated from the Pedagogical University in 1998. Currently, he is teaching in two public schools and a private school. This is a common situation in Mozambique where most of the teachers teach in more than one school. Casimiro was Dean of one of the schools for more than seven years. Casimiro's opinion is that my story reflects his view of my teaching when he was my student-teacher. For Casimiro, the main advantages of this method are that it stimulates production of didactic material, connects theory

and practice, and allows students to talk and exchange experiences (Casimiro's responses – Tape#2, 003). The main disadvantage for Casimiro is that my method is only adequate for classes with no more than 25 students. He stated that in trying to follow this method his main difficulties are the number of students (70 students or more) and the unwritten policy existing in schools that a large proportion of each teacher's students should achieve good results on the exam.

I am happy that I have included my former student-teachers in this chapter. My purpose in doing so is to help me confirm my awareness of the way that education is embedded in Mozambique. Casimiro's responses represent what I have understood in our conversation and sounded true to me. Hence, the responsibility for what has been said here does not lay with Casimiro but with me.

I was heartened by listening to Casimiro. He was describing the problems that I recognised, although not exactly with those characteristics. Long after listening to my former student-teachers (perhaps six months) it came to mind that the way that we see our problems also reflects the way that we have been educated. Then, I asked myself what my contribution was to Casimiro and his colleagues' teacher-education.

One example of the way that I used to educate my student-teachers using Locally Available Materials Technique comes from how we used to analyse Newton's Laws; this obviously reflects my own way of learning.

Figure 3.3 Isaac Newton as Alchemist.

Figure 3.4. The science included in nature.

The way I learnt and used to teach was in line with World Modern Science and relied on students learning about forces applied by machines and other tools. I agree with this view of force but we should also have space to discuss the existence of different types of forces and the beliefs and myths associated with this concept in our society. This can help us know more about ourselves.

Newton's First Law

Newton's First Law states that force should be seen as the cause of changing or creating movement. Usually, I suggest to my student-teachers that one way of starting to teach this concept could be to ask students if they have heard of the word 'force', and if they know what it means. In my experience, the responses generally, were: *Yes, we are familiar with the word 'force' and it means that we can walk, wash dishes, prepare charcoal for cooking, wash clothes, and iron. In special cases, we apply forces during our disputes and, in general, those that have the bigger force win. A life force helps us to do our daily activities but abandons us when we are sick. In our world to have force is an essential condition for survival.*

My response was: *Good! You, understand the concept of force that I wanted to teach you but, unfortunately, your knowledge is not what World Modern Science says. Please bear with me and I will help you to discover the scientific knowledge. Can you please look at the similarities of the phenomena that you have described?* This is usually a demanding question for students. With varying amount of effort, my secondary school students and I were able eventually to somewhat understand the World Modern Science view of force. After this, I asked students to give examples of phenomena where a force is acting. A car stopping or starting to move, a car changing its movement, a child sweeping the floor or opening and closing the door were examples given by students. I discussed with them the appropriateness of their examples and, in each case, asked them to identify where the force is applied. Then I asked them if they could push over a wall. With the expected answer, No! We then went on to discuss it. I used this example to emphasize that according to World Modern Science we should talk about force when we initiate or change movement. I finished the

teaching of Newton's First Law by giving students home work involving exercises from their text books. For Casimiro and his colleagues at Pedagogical University, the simulation of the teaching activity of this law was relatively easy.

Newton's Second Law

According to Newton's Second Law, the acceleration of an object is dependent upon the net force acting upon the object and the mass of the object. The net force can be calculated using the formula **F** = m**a**. This can be stated as:

> *The acceleration of an object is directly proportional to the magnitude of the net force **F** upon the object and inversely proportional to the mass m of the object. The net force **F** and acceleration **a** has the same direction and orientation.*

My intention as a teacher was to have my students believe in the validity of Newton's Second Law by solving the problems listed in the students' text book. A problem with the concept 'net force' and the interpretation (assimilation) of problems was that the problems were worded in Portuguese and this confounded my intent. In the simulations, Casimiro and his colleagues as well my secondary school students built ramps using the long tables that we have in our classrooms. These simple methods could confirm that we can produce a uniformly accelerated motion and that with our ramps at different angles we achieved different accelerations.

Simulation of teaching Newton's Law

The simulation of teaching activities of Newton's Laws in our Physics laboratory used everyday materials. My only rule in these sessions was that no one could criticise without describing a positive aspect of the lesson that s/he has witnessed. I enjoyed teaching Casimiro and his colleagues how to teach World Modern Science. However, my teaching was limited because it did not include concepts used by my people; for example, how to set up traps and to pound maize. The referred concepts could help me to answer questions such as: How does the hunter know that this particular branch of a tree is adequate to hold this kind of animal?

How can we measure the force to pound maize or peanuts? Newton's Laws are answering those questions but I am interested to know how the questions are handled, for example, in local-indigenous knowledge. According to my experiences some concept(s) of force are used because in the hunter activity mentioned above I could hear my fellow hunters saying 'do not use that branch of the tree as it will break easily; this one here is more likely to hold the animal'. Is it possible that there was no modern and analytic knowledge of forces applied, just local-indigenous knowledge gained through generational instruction and experience?

Some years ago I asked myself, 'How can I bring more concepts connected with students' lives into the science classroom?' Now I have changed the question to ask, 'Can I include stories from my society to incorporate discussion about the use of concepts from local-indigenous science and World Modern Science? Can I bring into the science classroom people with local-indigenous knowledge to explain their perception of those concepts? Although I am an educator, I do not see myself as a reservoir of all the knowledge that exists in Mozambique; however, it is my obligation to facilitate/create conditions for students to be exposed to that knowledge.

My teaching at that time was characterized by the use of Locally Available Materials Technique. Unfortunately I was doing this in such a way that 'what was happening at home' only allowed the acquisition of 'new knowledge' – World Modern Science. We were using Locally Available Materials Technique to make World Modern Science familiar; in other words, to allow one-way border crossing (Aikenhead, 2001; Giroux, 1993)

Revising my teaching, I think the impact of Locally Available Materials Technique on my student-teachers would be different if instead of using them to disseminate World Modern Science I was, at the same, time disseminating how local communities solve their specific problems, disseminating their explanations and the logic used. Why did this not happen? If my intention was to bring students' cultural knowledge to build on it scientific knowledge (World Modern Science) it seems that this shows how powerful habits and customs are. Although

I wanted local-indigenous knowledge, I looked at it from within the World Modern Science perspective that I was familiar with. Today, based on postgraduate studies, I affirm that the hegemony of World Modern Science in Mozambique is not due to its nature (epistemology and ontology) or the old curriculum that promoted it but to the political stance of giving it more importance than it has.

The Mozambican curriculum and my teaching

A new curriculum for general secondary education, called 'Plano Curricular Do Ensino Secundário Geral (PCESG)'(Cultura & Educação, 2006), in English, 'General Secondary Curricula Plan', was introduced in 2007. It recognised the inadequacy of the previous curricula that have been guiding education in Mozambique. This new curriculum tries to address the problem of education in Mozambique, one that is characterized by a high level of failure in primary and secondary education as well as a high level of theorizing. Hence, the aim of PCESG is to generate skills for life, skills that help to find employment, skills to continue with studies at a higher level, and skills that will lead to a profession. The previous curricula, according to Cultura and Educação (2006), was inadequate for a number of reasons. It had:

- *A lack of horizontal and vertical articulation among the units taught in secondary education; none of them had specific objectives or common objectives.*
- *A high level of theory taught at secondary level that did not have any link with the skills required to find employment.*
- *A focus only on the continuation of studies at a higher level.*
- *A low level of understanding of Portuguese.*
- *A focus only on World Modern Science instead of looking also at Technology.*
- *Little integration of knowledge; consequently, each unit dealt with knowledge without linking with knowledge from other units.*
- *Promotion of memorisation of concepts and formulas, and mechanization of procedures.*

Figure 3.5. Railway bridge on a river in Boane.

Figure 3.6. A panorama that includes the river under the bridge.

My teaching and learning has been constrained by the view that students should learn to build bridges as in the picture without looking to themselves.

Indeed my teaching was constrained by the previous curricula. By ‘constrained’, I mean the lack of freedom as a teacher to alter by adding or reducing the content or by changing the order, given that the majority of students were Black Mozambicans. PCESG is a government attempt to minimise some of the constraints by looking at Mozambican problems in secondary education; the clear intention and consistency of this work deserves to be acknowledged. There are, however, weaknesses in this document which reduce its potential for change. One, weakness is that the curriculum focuses on what has been done and not on what should be done. It seems that the proponents of the PCESG are suggesting that the issues identified in the previous curricula can be solved by the objectives that they set up using a wide range of sources. The document refers to sources within the Mozambican government, other governments in the world, non-government organizations in and outside Mozambique, regional and United Nations

organizations involved in education and the education agenda designed for Mozambique until 2025 in order to draw objectives for the Mozambican national education system (Cultura & Educação, 2006).

The education agenda designed for Mozambique until 2025 has four strands that direct general secondary education and aim to offer education according to the environment, situation, and needs of each child: (a) know to be, (b) know to know, (c) know how, and (d) know to live together and with others. The new curriculum reflects two of the priorities of the Mozambican government (2005 – 2009). The first is curriculum reform in general secondary education in order to make it more integrated and to include aspects of technical training. The second priority is to reduce the level of student failure in general education to 15% by 2009 (Cultura & Educação, 2006).

Another aim that I believe should be included in the new curriculum is 'local cultural development'. The word 'culture' is rarely mentioned in the document but I believe that local cultural development (see Chapters Five and Six) depends on the curriculum. In Mozambique we have had for the nearly 500 years of colonial time only one type of curriculum, one that was characterized by World Modern Science. The results have been disastrous, with a low level of literacy and increased alienation from our own culture. At the same time, other countries (I am thinking about European countries) using similar curricula have apparently achieved strong development, high levels of literacy and identification of citizens with their countries. I am aware that, apart from the curriculum, in Mozambique we have had other constraining factors such as colonialism, racism and the declared intention of inhibiting the education of Mozambicans. However, as we erased these factors we have remained with the same World Modern Science curriculum and the results have remained poor. I am persuaded that the consequences seen in Mozambique are largely due to the inadequacy of the curriculum. Ironically, the solution to this inadequacy is not to get rid of World Modern Science but to maintain it and include other ways of explaining the world around us, such as local-indigenous knowledge.

In my experience, few teachers in my profession evaluate and publish their thinking about curriculum and teaching. Is this due to the way that we were educated? I cannot tell, but the fact is that the struggle, the learning and the events that occurred in my classroom and in different ways in my former student-teachers' classrooms have rarely been documented in Mozambique. We science teachers and science teacher educators need to start to describe and publish our stories at the level of the class, school, district and nation. In journals, teachers and students could recount their journeys through the education process while educational workers and members of society in general could reflect and publish their opinions about education. I see these publications as a necessary condition if transformation of and reform in our education system are to occur.

My experiences tell me that the way we have been teaching science is largely responsible for (a) the large number of failures in secondary school, (b) promotion of Western hegemony, and (c) the indoctrination of Western habits. Looking at the distribution of subjects in the first and second cycles in PCESG, we see that there is little which distinguishes the subjects in Mozambique from those elsewhere in the world. The 'little' includes Mozambican languages which are optional. I question how we can claim that our interests have not been promoted by these subjects previously and that now, with changes only in the objectives, the same subjects now serve our interests? For some authors, our interests will be served when the teaching process works as a vehicle to transfer technologies that reduce our vulnerability (Agostinho et al., 2006). These authors argue that teaching should also guarantee the acquisition of basic health knowledge and support the positive values and attitudes required in communities. I agree and I support this stand, but my position is that at the same time that we are importing this knowledge let us also use and develop our local-indigenous techniques and knowledge.

It seems to me that the best way to introduce local-indigenous knowledge is to change the actual teaching of World Modern Science by discipline to teaching by themes, extending from primary level to secondary education. The themes could vary from school to school and within schools. A given school could chose the themes, for example, of communication, health, social relationship and

social security. In this way teaching in the science classroom will be culturally contextualised and the science classroom and school in general will become a visible place for the encounter of cultures. In other words, students and teachers will bring inside the classroom the different knowledges that they have.

Have I Been Including My Culture in My Teaching?

My past teaching also reflects how I was educated; hence, this question is addressed in the following story that I call 'science agency activated by school'

Science Agency Activated by School.

I am Felisberto, a 12 year old child. I was born after Independence. I have just one sister, Ema. My father is a well known mechanic in Maputo, the capital city of Mozambique where we live. My mum has done a doctoral degree in Systems Management. My sister and I had every kind of toy in our childhood, including our own television and radio.

During one lesson at standard 8, my teacher, Mario, brought many pieces of some sort of apparatus to class saying that, in groups, we were going to build radios. Until that time I had thought that radios were made in a shop. My family and I used to go shopping in several parts of the world.

Mario told us to connect the parts called the transistor, antenna, speaker and variable capacitor, following the schedule that he placed on the blackboard. The main goal was to demonstrate a physical application through the variable capacitor that people manipulate when they want to change the radio station. After this lesson, I was astonished. I realised how wrong I was to think that everything came from the shop. Were human beings like Mario and me, who were building things, applying physics. Me! I could be the one teaching people how the radio works. Is this really what I want to do in the future? I think I would like to know like a 'science mother', the one that covers all disciplines. This business of knowing just one part of science is boring because it makes the knower ignorant of other parts of science. Let me talk to the teacher.

Felisberto: Mr. Teacher, thanks for the lesson. I learnt a lot. I learnt that I could build things instead of buying them in the shop.

Mario: It is true. Everything that you see is a product of human beings.

Felisberto: This is my problem teacher. I would like to understand everything. Can physics help me?

Mario: In the beginning all sciences were concentrated in physical science. Scientists were called 'the friends of knowledge'. With development, the phenomena were categorized as biological, chemical and physical. But our goal is to explain all phenomena with only a few laws, instead of what is happening now.

Felisberto: Thanks so much, teacher.

After this conversation I decided to be a physicist, to help explain the phenomena that are occurring in the world, with only a few laws.

My story shows how Felisberto's culture of buying everything was not included in the science classroom. One way of doing this could be for Mario to involve students in the purchase of the materials used in class. There are many reasons why Mario did not adopt this procedure. In my case, as a teacher I did not include my culture in part because the curriculum that I was using, which was the basis of my own education, ignored local culture. My teaching did not include my local-indigenous culture because the philosophy behind the curriculum that I was using to teach inhibited the inclusion of local culture that I am proposing through the cultural model of teaching (see Chapter Six). My goal through cultural model of teaching is not only making students proud of their culture but to awaken their critical reflexivity (see Chapter Two).

In Mario's lesson the absence of critical reflexivity is shown by Mario and his students not questioning the affordability, usefulness and interests promoted by the technique of building a radio. Perhaps, by addressing these issues Mario and his students could come up with the question of how to produce the parts that allowed them to build radios? Students in the classroom were faced with a world they knew little about and worse they did not have an opportunity to reflect critically on this new world, only to embrace it as Mario and the curriculum had determined: as radio builders. Another story called 'how to activate science agency' further illustrates this situation.

Figure 3.7. Women selling fruits in Mozambique.

Figure 3.8. A buyer?

Our culture is shown also by how we communicate, what we wear and how we interact

How to activate science Agency?

My name is Xlhupenko. I was born in the capital city of Mozambique, Maputo. I have been teaching science for more than 10 years. I love my job and I think that students love me. My little success and many troubles make me question if this is the right way of gaining bread?! Do people who sell fruit (Figure 3.7 and Figure 3.8), for example, face the same problems as I do? What worries me is that the students' results do not correspond, in my opinion, to their efforts or mine. I cannot honestly figure out what is wrong because I carefully prepare each lesson. For example, let me summarize the lesson on Newton's Second Law. In the first step I show the students the formula, **F** = m**a**. *I explain the significance of the symbols,* ***F****, m , and* ***a,*** *and we take time trying to learn the Law "the acceleration that a body acquires is directly proportional to the sum of the forces acting on the body". The second step is to tell the students that they will solve problems looking for one variable. That is, they will be given, for example,* ***F*** *and m , and their task will be to find* ***a****. Obviously this will be done at the level of difficulty that*

corresponds to this level of schooling. The third step is just to solve problems in class, guiding students step by step. Then they go home with some exercises to do for homework, let's say fifteen exercises in two or three days. Do these fifteen exercises sound like too much? I have been justifying to myself that this number of exercises is required for students to assimilate the vocabulary, procedures and knowledge in this new world. This doesn't look like too much. The students, in a few days, have to acquire the new vocabulary and solve the problems. The curriculum doesn't allow me much time. Therefore students have to practice hard.

If I had more time I would like to include in my teaching the physics concepts included in collecting and transporting fruit from the tree - mangos and from the field – pineapple (Figure 3.7 and Figure 3.8) to the house and to the place that they sell them as well as the concepts involved in the preservation of these fruits. The main sources of my frustration are two: students' results and the usefulness of the knowledge that I am teaching.

I have Used Mario and Xlupenko as pseudonyms to preserve my role as researcher. The way that I have taught Newton's Laws in the past is the result of trying to make World Modern Science accessible for my students. Am I a vector for World Modern Science? I often found myself reflecting on how I could teach Newton's Laws in more interesting and comprehensible manner. Other times I wondered how I could make the process of learning physics easier. In both cases I was hoping to acculturate (see Glossary) my students into World Modern Science, a process that would make them not give value to their culture for years to come.

With my experiences of teaching Newton's Laws, the following questions arise:

- Do students' need this narrow concept of force to survive or succeed in their lives? My view is that this way of teaching should only be for prospective physicists.
- For general students is it necessary to teach 'all' aspects of force? I think so, and thus students could learn about: the lower level force, of being persistent; the force of doing bad/good; the force of discipline; the force

that united us in Mozambique; the forces which drive our lives; the force that allowed us to see the effects of the destruction of war and the civil war that we went through in Mozambique; and spiritual force. Students should also understand clearly the context in which these alternative views of the force are valid.

- In the assessment these could be included questions such as 'which forces would you like to develop and why?' 'How do you avoid the bad effects of force?' In this way we will be teaching the World Modern Science concepts and logic and also other logics and concepts of viewing the world, including local-indigenous culture.

How Could I Include Local-Indigenous Culture?

A categorical response for this question is not possible because culture (see Chapter Five) is not defined in a categorical way. The response to this question is not at the level of culture but in the policy that allows that culture to be included in the science classroom. I have not included Mozambican culture in the science classroom because my teaching aims were not to develop that culture. The content that I taught did not come directly from that culture. How then can Mozambican culture be excluded from the science classroom in Mozambique?

Mozambican culture is inside the science classroom because teachers and students are Mozambicans and their way of dressing, speaking, communicating and doing things represents Mozambican culture. Hence, the question of how I could include local-indigenous culture translates to 'how could the culture that was already inside the classroom be included in science teaching? The response is, again, in the curriculum that I was using; it was not designed to promote Mozambican culture.

How can we have a curriculum that promotes Mozambican culture? I have made in Chapter Five my proposal for a curriculum that encompasses cultural sensitivity. In this present chapter I am analysing how I have been teaching and today I am wondering if my teaching has contributed to the widening of the epistemologies and ontologies used in the science classroom in Mozambique.

My Understanding of Being an Educator

The analysis of my experience of teaching has contributed to the understanding of my praxis as a Mozambican science teacher educator and physics teacher. This understanding can be framed by epistemological and ontological paradigms. An epistemology (Corporation, 2006a; Halsall, 1999; Matthew, 2006) tries to answer the question, 'How do you know what you know?' It focuses on the significance of knowledge, its source, nature and limits as well as the methods of obtaining this knowledge. There are many theories based on the understanding of epistemology such as empiricism, idealism, naïve realism, phenomenalism, pragmatism, rationalism, representationalism, reliabilism, relativism, skepticism, contextualism and invariantism. My understanding is that these theories are not exclusive of each other but can be viewed as the many faces of any figure with 12 sides or more. The theories mentioned above are firmly connected and when integrated have the power to explain the knowledge possessed by human beings.

My World Modern Science learning and teaching experience was characterised by an empiricism which claims that knowledge is gained through experience, particularly naïve empiricism which affirms that our knowledge should be accepted or rejected to the extent that it is observable. This is what characterizes World Modern Science, at least in the form that I was taught and I was teaching. The problem I have realised in my study of this epistemology is that, in addition to being narrow, it does not allow Mozambican students in Mozambique to express and analyse their own local-indigenous knowledge. I believe that local-indigenous knowledge should be brought into the science classroom and viewed as part of an integrated perspective of existing epistemological theories. Integrated epistemology allows students to learn about the dialectical complementarity of different epistemologies within and between World Modern Science and other cultures. This can activate an individual agency to focus on local-indigenous epistemology (Taylor & Willison, 2002).

Ontology (Corporation, 2006b; Matthew, 2006) is the study of the nature of existence, reality, and substance in which the main focus is to determine what exists. Because of this, it determines a personal 'reality' and consequently one's

stance in the world. There are four main ontological approaches: realism, empiricism, positivism and postmodernism. My experience of learning and teaching excluded a postmodernist ontology which allows individuals to focus on themselves. In Mozambique, in the science classroom, there is a need to include a postmodernist ontology so students can focus on their personal experiences to develop their local communities.

Teaching from within World Modern Science ontology and epistemologies I brought everyday material into the science classroom and used them to demonstrate how World Modern Science is valid. Hence, I continued the colonialist deculturalisation begun in my own education, while using everyday material to induct students into World Modern Science and to remain unaware of their own culture.

One of my concerns when I collected my interviewees' responses was to find out how they were implementing the Locally Available Materials Technique that I had taught them (Cupane, 2003). In order to understand how they were using these experiments I asked them during the distribution of the questionnaire to choose a unit(s) among the subjects that they were teaching and to give me details about their use of Locally Available Materials Technique.

Table 3.2. Frequency of use of Locally Available Materials Technique by my former student-teachers.

	Teachers' Nickame	Grade taught by teacher	Chapters in the unit	Chapters in which Locally Available Materials Technique are used
1	C Francisco	Year 11 and 12	5	2
2	A Nazare	Year 9 and 11	7	All
3	P Instrumento	Year 8, 9, 10	4	2
4	E Comida	Year 10	5	0
5	T Stocks	Year 10	-	-
6	Tilu	Year 11 and 12	6	0
7	Dala	Year 10 and 11	5	1
8	Casimiro	Year 9 and 10	7	0

Table 3.2 shows that four teachers out of eight, all of whom were taught to use Locally Available Materials Technique, are only using them selectively. Only one teacher among the four indicated that he was widely using this approach. The

other three teachers are using Locally Available Materials Technique in half or less than half of the chapters in their curricula. From Table 3.2, it is difficult to be confident that these teachers are making much use of the Locally Available Materials Technique.

The eight teachers, who also responded a questionnaire, gave a range of reasons for their use or nonuse of Locally Available Materials Technique, as summarised in Tables 3.3 and 3.4.

Table 3.3. Categories of reasons for the use of Locally Available Materials Technique.

	T. Nickame	**Categories of reasons**
1 and 2	C Francisco and Casimiro	To simplify the process of teaching
3	P Instrumento	The material is locally available
4	E Comida	It is more easy to get students involved
5	T Stocks	It saves time
6	Tilu	It is easy to get the local material
7	Dala	It is easy to acquire the material
8	A. Nazare	Lack of laboratory

Table 3.4. Categories of reasons for not using Locally Available Materials Technique.

	T. Nickame	Categories of reasons
1	C Francisco	It is necessary to associate local material with other conventional ones
2	Casimiro	Locally Available Materials Technique can be only applied to some themes
3	P Instrumento	Locally Available Materials Technique require other material that I cannot get in the market
4	E Comida	Because chapters require conventional materials that do not exist in the schools
5, 6,7 and 8	T Stocks, Tilu, Dala and A. Nazare	I do not have conditions to do these experiments

Follow-up interviews with my former student-teachers revealed a number of reasons for the lack of usage of Locally Available Materials Technique. One of the main reasons is that the situation in the schools is very different from the Faculty of Science and Mathematics at University. In T Stock's words:

> *While in the Faculty we had test tubes and all the equipment for experiments, now in schools we do not have this equipment. For example, a piece of wire does not exist. Even paper is very hard to find in school; that is why it is very difficult to apply Locally* Available Materials Technique. Local available materials *involve low costs, but nevertheless there are costs, and schools are not making any money accessible to teachers to contact schools who have equipment. The idea of preparing material for experiments at home and carrying them to school or to ask students to bring material for me is not practical, because I am teaching in more than one school, and the schools do not have a store room to keep the material. So, preparing material at home means that I have to take them to all the schools that I am teaching in on that day* (Tape#3, 015).

Figure 3.9. Observing hippopotamus.


Figure 3.10. The hippos.

Can we in Mozambique use nature as one of the tools in the Locally Available Materials Technique?

The eight teachers agreed that there is no incentive in schools to do experiments. They are not spending time preparing Locally Available Materials Technique because the time spent in the preparation of experiments will not be paid. Another reason that became obvious in the interviews is that using Locally Available Materials Technique in some cases requires the use of conventional equipment; therefore, it is difficult to do experiments in some chapters. There are examples where teachers are motivated to do experiments. One of them was when the school where one of my former student-teachers, T Stock, is teaching was invited to go to another school to help teachers who are not yet fully trained. In this

instance, teachers were given a car and money and were asked what they needed to facilitate doing the experiments. Even conventional equipment like an ammeter, which usually does not exist, was made accessible to the teachers to demonstrate the experiments. This was very good, however in everyday teaching the same conditions are not available to teachers in most rural schools.

It is often difficult to do experiments because teachers are teaching in more than one school. Because of this teachers are spending as little time as possible in each school. To do experiments requires that teachers arrive some time before the class and spend more time after the class in school. In their opinion, since time is not paid:

> *Schools should add two or three more hours than the time required for classes* (E Comida, Tape#3, 083).

Another hindrance to doing experiments is the number of students in each class, and the number of classes that teachers have per day. One of the teachers said:

> *On average I have five 65 student classes each morning. Talking until mid-day, I am tired. It is possible for me, to do experiments in the first two classes, but I am so tired by the third one that I cannot do any experiments. Another difficulty that I am facing is that when each student has his/her own material, the difficulty, for me, is to give individual assistance* (C. Francisco, Tape#1, 045).

Somehow Locally Available Materials Technique is being conducted. E Comida said that this happens when materials can be found in the classroom. For example, for teaching the concept of inertia it is possible to use rulers and coins because students usually have these kinds of materials. To show the spectrum of the sun, the transparent tube of a pen can be used, if conditions allow.

Understanding my former student-teachers

I think the fact that these teachers were my student-teachers interfered with the reasons that they gave for the lack of usage of Locally Available Materials Technique. It seems to me that because I was their teacher they were trying to

show me that they are ‘perfect’; in other words, that they have succeeded in both my unit and at school, and that the problems are attributable to the conditions that exist in the schools in which they are teaching. Some of these conditions include the lack of material, the large number of students, few rooms and poor remuneration. Their stand can be viewed from two perspectives. The first perspective is the teacher’s role in the classroom. Kilbourn (1991) affirms that:

> It is the teacher who has responsibility for what happens in a classroom with students, not the person giving feedback. It is the teacher who must weigh alternative strategies, plot courses of action, intuitively respond to immediacies, and existentially accept responsibility for the conduct of the classroom life. (p. 151)

This means that if they believe that Locally Available Materials Technique can improve the teaching-learning process then during the interview they could have referred to the effort that they were making in order to use the Locally Available Materials Technique in their classrooms. Although I agree with their position about the poor teaching conditions and the weaknesses of the education system, I also believed that we need individual effort to change the situation. These interviews have inspired me to propose a cultural model of teaching (Chapter Six) in multiscience education.

Hunter (1984) affirms that teaching is a factor that can accelerate or retard learning and is formed by the choices that teachers make before, during and after interactions with students. The choices are based on judgements related to content, explanations, activities and students’ learning. Therefore, teachers and not the system are the ones who can decide to use the Locally Available Materials Technique.

Despite being trained in the use of the Locally Available Materials Technique, the teacher’s belief system seems to play an essential role in the way that those I have interviewed teach. According to Black and William (1998), my former student-teachers might be assuming that knowledge is to be transmitted and learned, that understanding will develop later, and that clarity of exposition accompanied by rewards for patient reception are the essentials of good teaching;

hence, the use of Locally Available Materials Technique is hardly necessary. In Black and Wiliam's (1998) words, using Locally Available Materials Technique does not mean that:

> … individualized, one-on-one teaching is the only solution; rather we mean that what is needed is a classroom culture of questioning and deep thinking, in which pupils learn from shared discussions with teachers and peers. (p. 8)

My former student-teachers seem to be saying that not all the time that they are spending at school is paid and that schools are not making money available for them to purchase equipment. This implies that if they could receive more money or spend more money on equipment they would teach better. Another view in relation to poor remuneration and conditions at schools is given by Guber (1999):

> While it may be difficult to deny the importance of money and all it can purchase, critics of educational reform in Vermont and elsewhere often counter that the amount of money schools spend per student has no systematic relationship to educational performance. (p. 1)

The second perspective in which we can view the stand of my former student-teachers is that alone they cannot change the situation. For Sirotnik (1983) and Sykes (1988), even inside classrooms teachers are alone, talking, while the students are listening. The interaction between teachers and students is made by "closed and factual questions" (Sirotnik, 1983 P. 29). The teachers find themselves in the dilemma of whether to keep on doing this and accomplishing their task of delivering the content or not finishing their program. The level to which the program is accomplished is one of the elements that the supervisors use to judge teachers' work, as they do not have time, and in many cases skills, to follow teachers' activities. These constraints, in my opinion, are created by viewing the curriculum as content or subject matter used rather than as an integrated approach to learning (see Chapter Six for a discussion on this).

Understanding the 'self' starting this research

The question that I am addressing in this section is "h*ow did my learning of science help me to recognise myself as Mozambican?"* Something that needs to be understood before addressing the question is the concept of "self recognition". I became aware of and began to examine this concept when I started my Masters Degree. The meaning of self recognition can be found through questions such as: Who am I? How have I been working and living? What are my values? On reflection, I doubt if Beleza Jorge and Horario had this understanding of self recognition when they attempted to answer my questions.

Self recognition means to know why I am doing what I do and to question if it is possible to continue to do the same thing in a different way. My self recognition has evolved from the earlier view that I am a vector of World Modern Science to the current view that I am an emancipator of myself and also of my colleagues, people and culture. Self recognition helps me to pay attention to the transformation that is occurring in me and in the society where I live, and to question the reasons for making changes in Mozambican society.

Having in mind these two concepts (self recognition and being Mozambican) I cannot really say that my learning of World Modern Science helped me to recognise myself as Mozambican. My learning of World Modern Science did not help me to question how things were happening in the ways that they were happening. It sometimes gave me the sense that I could explain what was happening and that in a different world I could do things in a different way. The learning of World Modern Science created the feeling in me of becoming different from my people and somehow superior: I was acquiring knowledge that they did not have. The focus of my learning was not on the Mozambican situation but on a collection of facts that could be explained by physical laws. I once read in one of my schoolbooks that it does not matter who is measuring if it is raining outside or if it is shining, or the day of the week on which the measurement is made. What is important is the collection of elements that can be reproduced elsewhere to get the same results. This kind of teaching was done throughout my student time and I have repeated it as a teacher and science teacher educator.

Does it make sense then to discuss the issue of 'the learning/teaching of science that helps the learners to recognise themselves'? This is one of the questions that I had hoped the answer to which would help me to assess the culture sensitivity of the respondents. For those who were not interested in Mozambican culture, the answer could be no. But I did not receive this 'no' from my respondents. Another reason for inquiring of colleagues to characterize my experience of teaching/learning is the cultural diversity that exists in Mozambique. How can the education system in Mozambique be directed towards our cultural diversity?

Reflection on my learning/teaching experience is part of the movement aimed to make the Mozambican educational process more Mozambican. I have concentrated on science education in high schools, where my experience is largely based on being either a teacher or teacher educator. In my opinion, three steps are necessary to redirect the Mozambican education system so that it becomes a factor of cultural diversity development. The first step is to recognise that to keep the current structure of teaching science does not fully serve Mozambican interests; the second step is to adopt what I call 'Integrating teaching'; and the last step is to (re)define our educational aims, having Mozambicans as a referent.

Figure 3.11. Is this scenario Mozambican?

The first step, the actual structure of teaching science (Biology, Physics, and Chemistry) does not fully serve Mozambican interests, only the interests of those who are looking to become biologists, physicists or chemists. One reaction can be that Mozambique also needs scientists and technicians in these areas! So let us keep the structure like it is. My response is that not everyone has the disposition to be a scientist and to submit everyone to the same model probably is against their human rights. Those who succeed to become scientists also do not necessarily stay in the country (brain drain) or at least will work with a 'Non Governmental Organization' (NGO). Furthermore, those with an acceptable understanding of these fields may not be able to apply their knowledge in their settings. However, I emphasize that changing structure does not mean to change the paradigm on which World Modern Science is based, but to create more space so that other paradigms can be incorporated, for example, local-indigenous knowledge.

In the second step, my understanding of integration is that local-indigenous knowledge, which has not been allowed to be part of the education system, should be promoted: promoted by allowing it to be taught in schools; and promoted by recognising its validity in explaining the world around us.

Finally, the goals should be neither only to make scientists nor to 'reinvent the wheel'. Rather it should aim for understanding the complexity of Mozambican society: the place, people, problems faced by people to survive, and the relationship between humans and nature in the Mozambican context.

The activation of my Mozambican identity

During the colonial time education was aimed at alienating Mozambicans (see Chapter Six). I will resume my inquiry into the question of the extent to which the learning of World Modern Science helped me to recognise myself by first telling a story about how my science agency was activated. I have argued in the previous chapter that one indication of science agency is shown by students' willingness to understand what is being taught and to apply the same concepts to improve their living conditions. In this story I am using *Zulmira* as a pseudonym to preserve my role as researcher.

My name is Zulmira I would like to share my memories about my process of learning at school. I was born in Gaza, 300km away from the suburbs of the capital city of Mozambique, Maputo, at that time Lourenco Marques, where my family is still living.

My father was the first one to emigrate to Lourenco looking for work and better conditions of living. After deciding that he was established, he asked his relatives to find a woman for him. He followed both the traditional and Western union ceremonies of getting married. I was one of the products of this marriage. We were Machangana living in Maronga land, making an effort to keep our traditions. Conservation of our way of eating and speaking and the link with Machangana land showed how we were doing this. In Gaza were my grandparents and other relatives, and every fortnight my father used to send a bag containing bread, sugar, tea, and other things that were not available there. The following week the same bag was sent back to us with products like cashew nuts, fresh peanuts, fresh maize, and other things that were expensive or not available in the city. These exchanges were made by a transport company called 'Oliveira Transportes e Turismo'.

In the playground we used to play a game called 'zoto'. In this game you have to avoid being touched. After being touched you have to touch someone else. The game finishes when the players feel tired. Another game was called 'Matacuzana'. In this game a small hole is made and small stones are put inside the hole. The winner is the one who can take from the hole the largest amount of stones while throwing vertically another stone. There is a huge variety of Matucazana. Besides these two games we used to play 'Ntumbeleluane', 'Neca' and other games.

My father was a lorry driver and my mother a domestic. My father used to bring charcoal for us to sell and improve our income. I used to help my mother sell the charcoal.

My activities alternated between helping my mother and going to school. Looking back I think that my schooling was intended to create a new world for me

but one that did not include all the games that I had in my playground nor helping my mum.

My father did what he could to help me. During the weekends he was at home he used to open the newspaper and ask me to read or he would read aloud for me to take notes. He used also to ask me the significance or certain words.

I was making an effort to do my best in school because examples of people without enough to eat, living in very poor conditions, and doing very hard jobs for nearly nothing were abundant. And I was told that without school I would end up in the same circumstances.

I succeeded in school but this was the result of working against my feelings. The majority of my time at school was dedicated to things that did not have anything to do with my life outside of school. Addition, division, the human body and movement themes that were somehow related to my life passed too quickly. The majority of the time was dedicated to chemical equations, integrations, theories and laws that even today I consider distant from me.

My story shows that my Mozambican identity was not activated by World Modern Science in the science classroom. One collateral effect of having science agency activated in the way that I have described in the story above could be to see the learning of World Modern Science as a bridge to alleviating issues of poverty. Is there any connection between the 25% of students lost by our education system and this way of learning/teaching? Another problem that comes from science agency not being activated at schools is students not easily acquiring the notion of studying as a lifelong process.

In Closing

I have reviewed in this chapter my experience of being a Mozambican, a teacher and teacher educator in Mozambique. The intention of this review was to examine the extent to which I had included my culture in my teaching and how this could be improved in my future praxis. My conclusion is that, although Mozambican culture is always present in the science classroom, because of our way of speaking

and doing things that culture was not included in my science teaching, according to a social constructivist theory of teaching and learning.

How effective was my practice at that time? This is the second part of the specific research question one. When I was teaching I did not have the notion of social constructivism that appeals to the consideration of local-indigenous knowledge and different epistemologies of knowing. My wish was that my student-teachers, instead of teaching by rote, could use the Locally Available Materials Technique to conduct experiments and demonstrations. On the question of the impact of my teaching about how to use this approach, it seems that my former student-teachers are not making much use of this approach. In view of these results I started to question: Why are my former student-teachers not applying Locally Available Materials Technique in their teaching while we (I and them) used that material widely? Is there any difference in the way that I was educated and the way in which I was educating my student-teachers? Why is it so important for me that my former student-teachers use Locally Available Materials Technique? Is it important because of the results that they can get with their own students or to show that I am a good teacher? When the meaning of the last question hit me I was disturbed. Using my recently acquired social constructivist perspective on teaching and learning I realised that I had been promoting an exclusive epistemology of World Modern Science (see Chapter One) and that I had not been sure about the alternatives to that epistemology. It then came to my mind that, unlike my former student-teachers, I was born in the colonial time and thus I wondered: How different is my story of education from my student-teachers? Who are they? The readings that I undertook immediately after my fieldwork aligned with these emergent questions and helped me to address them in the next chapter entitled ‘Who Am I?’ – A Cultural Perspective.

In reviewing this chapter I conclude that it discusses culture and its inclusion in my teaching practice without explaining what culture is. Do I know what culture is? Is the Mozambican culture embedded in the Locally Available Materials Technique? Although I cannot tell right now what culture is I feel/think that it is an important element to embrace because it could help me to: (a) promote students’ interests, (b) learn from students, (c) examine assumptions and beliefs

that guide my life, (d) be vulnerable, (e) view the teaching-learning process not as part of students' lives but as a process of transforming them into life-long students, (f) teach about life itself, (g) change the strategies of teaching according to students' developmental needs and situation. Those are some of the outcomes that I am expecting from the next chapter.

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Chapter Four: Who Am I? – A Cultural Perspective

Introduction

> For some there is no simple answer when faced with the situation where it is required to tick a box that identifies the individual as: White, Black, Hispanic, Black British, Asian British, Afro-American, Afro-Caribbean and so on. Perhaps the category of 'Other' is more suitable, but then one may be faced with a long explanation that cannot be restricted to a line. (Golmohamad, 2004, p. 3)

Figure 4.1. The concept of 'pure race' was the cause of the Holocaust.

I was born and grew up at the end of the colonial era in Mozambique which had been colonized for nearly 500 years. In this period Mozambicans were inculcated with the belief that they were indigenous, black, inferior human beings with a culture that cannot be understood by the colonizers, leading Mozambicans to live in poverty and obscurity. However, my induction into World Modern Science (see Chapter One) was started by the colonizers in this 'sustainable[1]' colonial environment, where it did not make sense to ask 'who am I?' which is the question that emerged in the previous chapter, because it was established some centuries ago.

[1] By sustainability I mean (ironically) the social environment that was imposed and managed by the colonizers in which the indigenous, like me, could predictably run their lives.

How can I consider the colonial environment sustainable? I am surprised with myself, because we (Mozambicans) all believed that the colonial environment should be terminated by all means possible. Well, I do not have a better word to convey that my people and I, during the colonial time, could predict events in our life and knew the challenges to achieve the style of life allowed by the colonizer. This is in contrast with what is happening now, where our enemy is not easily identified and we are still struggling to make education accessible for all, in particular, our children.

My induction into World Modern Science was characterized by seeing science as a foreign language that had nothing to do with my life. I was obliged to master it in order to survive: rote learning characterized by memorization and Fatima's Rule (see Chapter Five) were also part of my learning experience (Gerdes, 1994; Kawasaki, 2007).

One of the main preoccupations after becoming a teacher was to help students to learn according to their needs. By 'needs' I mean their skills, scientific knowledge, physical environment, and problems in their lives. My experience of learning was that of teachers telling me that I needed a lot of rehearsing to be able to reproduce the scientific content learned in the science classroom. My colleagues needed less or more practice as they were failing or passing with better or lower grades than mine. So, I was questioning myself about how to make my students 'see' what is needed for them to succeed in my physics classes. How was I to perceive their needs given that they were from all over the country and from different ethnic groups and backgrounds?

My main constraint was the limited time available for approaching each student. I needed to deliver all the physics content to be assessed by the time of the national exam at the end of the year. It was necessary to deliver that content quickly as it was huge and students' only source of knowledge was me. So, I needed to make sure I made a 'good' contribution to students' examination success by delivering all possible content to be examined. Unfortunately, my students did not succeed in a way that satisfied me; hence the need to know better how to teach my students was the major motivation for me at the beginning of my postgraduate studies.

After explaining to my mentor what was moving me to do my postgraduate work, his reaction and the readings that he gave me raised key questions such as (a) Who are you? (b) Who are your students? (c) Who are Mozambicans? These questions are summarised by Palmer (1998):

> The question we most commonly ask is the "what" question – what subjects shall we teach? When the conversation goes a bit deeper, we ask the "how" question – what methods and techniques are required to teach well? Occasionally, when it goes deeper still, we ask the "why" question – for what purpose and to what ends do we teach? But seldom, if ever, do we ask the "who" question – who is the self that teaches? How does the quality of my selfhood form – or deform – the way I relate to my students, my subject, my colleagues, my world? How can educational institutions sustain and deepen the selfhood from which good teaching comes? (p. 4)

I thought that those were interesting questions and I understood them from my positivist background: I just needed to detach myself and see me as others see me - to describe my students and my people as an outsider using a third person passive voice. My hope was that by addressing these questions I could also explain why my former student-teachers were not making good use of Locally Available Materials Technique teaching in their classroom as I taught them (see Chapter Three). But it did not work out. I could not generalise about me, my students and my people. I was wedged, and to progress it was necessary to take the questions personally. To answer them from my point of view made me go through a cathartic process of reviving the pain and difficulties that I had experienced during the earlier time that I had been colonized and acculturated (see Chapter Five) into the science called 'Western science'.

My first response to the questions above was that my people, students and I are indigenous. Then, the disparaging colonial meaning of indigenous came to my mind and I questioned: Am I really an indigene? Does a Mozambican indigene know how to read and write? How can I be an indigene if I am in Australia? Then I realised that these many questions were expressing the anger of being humiliated by being considered indigenous. For days I doubted whether I would be able to talk about indigeneity because of the colonial influence attached

to bad personal memories. It took me at least a couple of months to decide that this is the greatest opportunity in my life to deconstruct scientifically the meaning of 'indigenous' and help myself first and foremost, as a Mozambican citizen and science teacher educator.

I started to search for a question(s) that could address my problems with indigeneity, especially the question I was facing in the field of education of being considered indigenous; hence I continued to question myself: (a) I have been indigenous for five centuries - how long will I remain indigenous? (b) Does identity in general change? (c) What is identity? (d) Does it make sense to teach other indigenous people while using a colonizer curriculum? (e) Who am I? This chapter constitutes my answer to these questions.

The focus of this chapter

The focus of this chapter is my learning/teaching experience in Mozambique, where I was born and live. My experience of learning and teaching can be characterized by curricula found in Mozambique before independence, after independence, and after the end of the civil war in 1992. The first experience was primarily with the colonial curricula obtained from Portugal. The second was with curricula strongly influenced by communist countries: The Union of Soviet Socialist Republics (USSR), Cuba, The People's Republic of China, and The German Democratic Republic (GDR), among others. The most recent curricula are strongly influenced by the characteristics of the free market. To what extent can these curricula be called Mozambican? This chapter intends to show that my identities were, in different periods of my life, imposed by the different curricula used in Mozambique. It follows, then, to ask the question: *to what extent can these identities be called Mozambican*?

I am using my own experience as a contribution to answering the specific research question 2 of this thesis: What are key opportunities and obstacles to making science relevant to everyday life in Mozambique? My first assumption is that by showing how my identities were influenced and, in some way, imposed by the curricula used in Mozambique, science teachers, curriculum planners and schools can reflect on how to teach science, which science to teach, and how to

influence Mozambican students' identities, where my experience is applicable. The second assumption enabling me to address the specific research question 2 is the necessity to know culturally Mozambicans. The exploration of my identity, imposed by different curricula, serves this purpose because it is, at the same time, the exploration of the identity of my ethnic group and the identities of the different communities in which I have lived. In my experience as a learner and teacher, I have interacted with people from many different ethnic groups; hence, I believe the experience of searching for my identity can be used extensively in Mozambique.

Figure 4.2. In Mozambique it is common that members of the same family cannot communicate in their local-indigenous language. In The Figure the child doesn't speak any Mozambican language and the adults speak Changana and Shona.

This thesis addresses the issue of 'cultural development'. I discuss in detail in the next chapter the concept of *culture*. The concept of *development* in this thesis is used in relation to education. My understanding of *development* is that it is a

change that will bring more advantages and fewer actual intellectual, emotional and material needs. This thesis can be also seen as a contribution to the debate on how Mozambicans can develop their education system so it can contribute to their development. As Schech and Haggis (2000) affirm:

> Whether capitalist or Marxist, development theorists and policy makers have identified development with material progress and improved living standards. But how these goals are best achieved, who should be the primary beneficiaries, and who or what stands in the way of development, have been matters of ardent debate. (p. 15)

There is "*development*" and "***the*** *development of*"; hence, *cultural development* is a broad concept. My problem is that I have been discriminated against on the basis of my colour, region of birth and language, and I have tried to distinguish who I am by using notions such as identity, nationality and patriotism. I grew up identifying strongly with one ethnic group (Machangana) in different places of Mozambique. Independence brought Mozambican notions and allowed cultural border crossing (Aikenhead, 1997; Aikenhead & Jegede, 1999) among our ethnic groups. Nowadays, the Mozambican population is so mixed that it cannot be as easily discerned as it was in the colonial era. Many Mozambicans live in places far from where they were born, and their parents have mixed ethnic backgrounds.

The situation in Mozambique and the rest of the world is challenging the notion of identity in order to accommodate diversity and pluralism in education. What is identity? What is my identity? Is it possible to promote cultural identity? These are the questions that seem to encompass my main dilemmas with the 'indigeneity' concept and help me to focus on my praxis as a science teacher educator; therefore, they constitute the major questions that I address in this chapter, using 'dialectical thinking'.

Dialectical thinking

Dialectical thinking is a way of thinking concerned with change and how opposites sit together. According to Spencer and Krauze (1996), dialectical thinking is not a method that can be "applied to whatever subject-matter" that you

choose; however, I see it as a way of applying ironic validity (see Chapter Two) to wherever you want to apply it. Dialectical thinking denies a single sided truth given by Aristotle's syllogism. An example of the syllogistic form of argumentation that dominated logic for 2000 years is "A is only A". For dialectical thinkers, this is only partially true because 'A' is just part of a phenomenon and only the entire phenomenon can give us the truth. Dialectical thinking, as proposed by Hegel, is a construction of entities (things, ideas, theories, beliefs, relationships) that provides less inadequacy or inconsistency. Inadequacy or inconsistency is illustrated by the 'negation' or 'contradiction' that each entity contains.

The notion and use of dialectical philosophy and analyses is well illustrated by the following examples (Rowan, 2003): (a) light makes sense because of its opposite (darkness); (b) the sense of love is given by the apparent absence of hate; (c) peace and war cannot exist separately. Thinking about the existence of opposites, it is possible to conclude that each of them contains the other.

> … there is some light in every darkness, and some darkness in every light. There is some hate in every love, and some love in every hate. If we look into one thing hard enough, we can always find its opposite right there. To see this frees us from the "either-or" which can be so oppressive and so stuck. (Rowan, 2003, p. 1)

The following two examples (Basseches, 2005) illustrate how dialectical thinking focuses on the process and not on the stages of the same process. (a) How to choose a partner? If we concentrate on ourselves and on the partner that we want to choose (a formalistic way of solving the problem), it will be hard to find a perfect match, but if we concentrate on the relationship that we want to create and the metamorphoses that will change us (a dialectical way of thinking), it can be much easier to solve the problem. (b) The same applies in the break up of a relationship: it is much easier to accept and analyse what happened if we look at the relationship instead of the people. Instead of trying to find out the extent to which you are responsible for the failure of the relationship, you should 'see'

yourself as one among other factors that drove the relationship until the break up: celebrate what you did well and try to have an open mind in a new relationship.

Dialectical thinking (Basseches, 2005; Rowan, 2003) is one philosophy among many others which places emphasis on 'transformation'. It distinguishes itself among philosophies by stating that the transformation takes place by the clash of opposition within the entity, which is easily understood because of the intimacy of opposites. The opposites that exist in each entity cannot be suppressed because they constitute the condition for the existence of the entity.

> So if we take love to its extreme, and idealise it, we get morbid dependence, where our whole existence depends completely on the other person. And if we take hate to its extreme, and idealise it, we get morbid counterdependence, where our whole existence again depends completely on the other person. This appreciation of paradox is one of the strengths of the dialectical approach, which makes it superior to linear logic. (Rowan, 2003, p. 3)

Dialectical thinking is usually structured in a triadic form: Thesis, Antithesis and Synthesis (Spencer & Krauze, 1996), see Table 4.1.

The Excavation of My Identity Using Dialectical Thinking

The investigation of my identity, especially the understanding of how that identity was imposed by curricula, is framed by dialectical thinking. In this frame, I analyse my experience of living in a colonial time, a socialist/communist time and a free market time.

I have deliberately used the expression 'imposed by curricula'. At this stage I remember that Mozambicans did not have other choices besides showing the behaviour that was expected from them. Hence, it was an imposed behaviour which was also sanctioned by curricula.

The understanding of my identity will help me to clarify my view of the curricula that we should have in Mozambique because, in my opinion, we are not only in a free market period, but there is an overlap with the previous two times, in a hegemonic way. In other words, we are living simultaneously in a traditional,

modern and postmodern society. By making clear who I am and which curricula are adequate for our complex situation, my colleagues and students may benefit as they are likely to be facing the same problems of curricula and identity.

Table 4.1. The triadic form of dialectical thinking.

Thesis	Antithesis	Synthesis
An entity is built and, on reflection, proves itself unsatisfactory, incomplete, or contradictory.	Is the affirmation of thesis negation which also on reflection proves inadequate.	The search for an entity with fewer contradictions.

(Adapted from Spencer & Krauze, 1996)

Each of thesis, antithesis and synthesis will be placed in terms of my identity.

Thesis: My identity is fixed

Figure 4.3. How fixed is the identity that all of us have?

Colonial curricula were based on 'essentialism' (Ashcroft, Griffiths, & Tiffin, 2000; Bilton et al., 2002; Semali & Kincheloe, 1999) which is an assumed set of fixed characteristics that define the establishment of a given category. A category can be, for example, Indigenous people, Africans, Americans, Europeans, Asians, White or Black people, Women, Men, Muslims or Catholics.

Hence, according to the essentialist perspective, you and I have a fixed identity. The notion of essentialism was established by cultural anthropologists in

an effort to name and categorize indigeneity. Essentialism, or *essentialist authenticity,* was produced separate from racial or ethnic expressions, which failed to place people in a specific category.

The notion of essentialist authenticity views indigeneity as non – existent in modern life. In this view, participants in modern life are false or adulterated; the prolonged interaction between Western and I(i)ndigenous people has destroyed the purity of the Indigenous people (Semali & Kincheloe, 1999). In other words, Mozambicans who existed before the 15th Century are more Mozambican than you or me because Portuguese colonialism appeared in our country at that time and now we are a product of impurification.

Obviously, not every indigenous person has the same knowledge because everyone has different strengths, weaknesses and gifts. Essentialists are looking for those who fully represent the culture in order to learn indigenous knowledge from them. However, this is a new racism: "racism based on ideas of cultural difference rather than on claims to biological superiority" (Bilton et al., 2002, p.178).

Essentialist policy in South Africa during the Apartheid era was responsible for ethnic and racial segregation. The intention was to keep 'pure' all races and to avoid contamination among races and ethnic groups. In this way, each ethnic group was reserved a certain territory in which to live, and the medium of instruction and communication was the ethnic language. However, I question whether South Africans are 'really' Africans simply because they were obliged to live in ghettos?

Ghettos in South Africa were regions designed to separate people according to their race, language or ethnic group in a violent manner during the Apartheid era. Nowadays, they still exist and they can be defined as:

> … enumeration areas where at least 80 per cent of the population are members of the same group, and such areas contain over half the population group. Further, it is suggested that ghettos are not ephemeral features but have a degree of permanence (Christopher, 2004, p. 246).

Is the culture kept intact in the ghetto, which serves as a symbol of oppression? Vital and Skovsmose (1997) suggest that repression based on culture in South Africa created a hatred of African culture in such a way that even today, in the freedom era, South Africans are reluctant to embrace education that has culture as a referent, such as ethnomathematics. But oppressed cultures cannot remain the same. They change according to the unfolding vision of the oppressed people.

In Mozambique, in contrast to the events in South Africa, we 'indigenous' were manipulated to acculturate and assimilate[2] the colonizer culture. The chief aim of Portuguese colonialism was to turn indigenous people into Portuguese. At that time Mozambique was called 'Portugal Ultramar', which translates as 'Portugal Beyond The Sea'. I remember that in my childhood Mozambicans were divided into those who were assimilated (see Chapter Five) and those who were non-assimilated. To be assimilated meant that you had grasped some Portuguese manners and ways of doing things; a certificate (pass) was issued to confirm this assimilation. It was not a peaceful process. In the presence of the colonizer, the assimilated are obliged to behave according to the colonizer's rules. For example, it was considered unacceptable to finish the food on your plate, a *faux pas* in Portuguese etiquette. This was necessary even at home, especially in the presence of strangers.

This is the process of living in contradiction: doing what you do not want to do, saying what you do not want to say and feeling what you do not feel. This is assuming the identity that the colonizer wants you to have. To what extent has this phenomenon adulterated people? While in Western culture it is polite to accept a compliment with 'thankyou', in contemporary Mozambican culture it is not. You must refuse it by saying something negative. For example, if someone says: "You have a beautiful house", you need to answer something like: "Oh yes, but I still have to pay for it". Has the refusal to accept compliments resulted from this dilemma of being Black and White at the same time? How is this dilemma reflected in other aspects of our social life?

[2] See Glossary the meaning of 'acculturation' and 'assimilation'

Nevertheless, I strongly disagree with the essentialist assumptions that the colonizers are the ones who made me lose my African identity. How can I have this stance if the colonizers were there and caused many tribulations and changes to occur? Yes, colonizers were there and instigated many changes but they were not the sole authors of these changes. The colonized are also authors of their changed (and changing) culture. I have changed my identity in part because of colonization. Colonizers, in their imperial and racist efforts, helped to create a false identity by using a 'universe discourse' (Errante, 1998). This official discourse was characterized by declarations, mimicry, attitudes and clothes that convey identification. Both the colonizer and colonized identities have been imposed and contested through formal and informal education since the arrival of colonizers in Mozambique in the fifteenth century.

The influence of colonial curricula on my identity

My identity has formed and evolved within the multiple contexts of being colonized, being independent, some years later being frightened because of civil war, and now being a researcher within my contemporary cultural context and living in a peaceful country after I have experienced a civil war. During these four periods, I have been struggling to decide what identifies me and what should guide my life. I do believe that my struggle ends with my encounter with Non/dualism that I develop later in this chapter. During these times, I assumed a collective identity because of my social interactions. This collective identity is given and maintained by discourses that induce pride (Errante, 1998). School is also the place where the imposition of these discourses occurs.

The official discourse during the colonial era determined that my identity was characterised by submission, ignorance, humility and acceptance of fatality. However, this discourse was imposed by a colonial power, especially in the schools. Errante (1998) cites the fourth-grade text-books where it was written:

> Obey and you will know how to rule"; "In the family, the father rules; in the school, the teacher rules; in the state, the government rules"; "When there is noise, no one can be heard or understood, that is why no one is respected in a revolution"; and "If you knew how hard it is to

rule, you would realize what greater enjoyment there is in obeying. (pp. 276, 277)

I wonder whether the colonial discourse and attitude is an indication of how the 'good behaviour' of students in Mozambican schools today was created or whether the colonial discourse and attitude reinforced any predispositions that exist in African cultures? I am thinking that in Mozambique we were under colonialism for 500 years and the imposition of this philosophy was rarely made in a polite way.

Figure 4.4. The biggest Catholic Church in Portugal.

Colonial authorities used the Catholic Church to support their official discourse, particularly after the fall of the First Republic and through the Estado Novo (1926-74). Although the State was separated from the Church, legal amendments were made to introduce Christian values into the teacher training and learning/teaching process. The main goals of school were to help people read, write and count well, have moral values and love Portugal. If teacher training and the learning/teaching process went beyond this, this was seen as too much pedagogy for teachers and unhealthy for children, particularly if they lived in rural areas. One form of discourse in the teacher training and learning/teaching process was the cultivation of humility. According to this discourse, God is the One responsible for the distribution of richness. The poor who love God and are hard working are happier than other people who are constantly worrying about their money (Errante, 1998).

Colonialism within education was evident in the dual education system. The first system, called *escolas de ensino official,* comprised official government schools set up for White people, Coloured people and Assimilated Blacks. The second system, called *escolas de ensino rudimentar*', meant rudimentary schools. These were transformed later into *escolas de adaptação* which were schools for 'adaptation' attended by the majority of Mozambicans, but offered only up to the

third grade of elementary school. The first and second systems had the same curricula which were covered in 4 and 6 years respectively[3]. This was the strategy to make sure that the majority, in general, would not make it to grade 4. The schools were located very far from people's village huts. Children started to go there at 8 or 9 years old and, by law, no one who was more than 13 years old was allowed to enter grade 4. In other words, by law Black students could progress to the official schools but the same law made it impossible to do so (Errante, 1998).

Identity is fixed (Essentialism)

- Skin colour, place of birth, sex, religion determines undoubtedly our identity

- The reality is explained by metanarrative

Figure 4.5. Characteristics of essentialism.

Another factor that cemented the identity imposed by the colonial discourse was the higher level of illiteracy and unemployment among the colonizers.

> [An] African's admission of competence could be a death sentence and almost certainly grounds for chibalo[4] or a beating with a palmatoria. Many found nothing would get them sent to chibalo quicker than for their White bosses to discover they could read or write when they themselves could not. (Errante, 1998, p. 296)

The movement against the essentialist colonial and Catholic discourse was initiated by the Swiss Mission. After the Colonial Act of 1930, the Swiss Mission began to organise a special education programme for young people which took the form of youth groups called *mintlawa* (sing. *ntlawa*, a Tsonga word for group). These youth groups are sometimes also referred to as *patrulhas* (patrols) in the literature, and their main objective was to shape the young through a Christian education (Silva, 1998).

> The education provided by the Swiss Mission, and particularly the informal mintlawa, were intended to stimulate self-reliance, develop

[3] For each year spent by White and Coloured people Black people where obliged to spend two. The curriculum was the same but for Blacks ended at grade 3 while for Whites it continued up to grade 4.

[4] Chibalo is a Bantu word meaning 'forced labour' which was used to build the infrastructure in Portuguese colonies.

> individual skills, broaden knowledge, promote Christian values and a new worldview. It placed particular emphasis on fostering skills such as information gathering and interpretation, critical analysis, and encouraging individuals to reflect on, and understand, their own position. (p. 226)

The Swiss Mission's educational approach was later adopted by other Protestant missions, particularly the Methodists and Presbyterians. In the same way that Protestant missions were increasingly working together outside the state, the Vatican and the Portuguese authorities were reinforcing their cooperation, formalised in the *Concordat and Missionary Agreement* of 1940, and the *Missionary Statute* of 1941. One of the effects of this cooperation was that the Portuguese state was shaped strongly by the Catholic church, with the latter serving the interests of the former (Silva, 1998).

Contradictions within essentialism

One of the contradictions within the essentialist view concerns the failure to account for fixed identity changing. Essentialists identify people by their skills, colour of skin and place of birth among other non-human characteristics. For example, if you are Black and use plant leaves to heal then you are labelled as indigenous, whereas White doctors using pills that come from the same leaves are not labelled as indigenous. The knowledge of healing with plant leaves, like any knowledge, improves with practice; hence, to characterise people by their skills does not necessarily tell who they are or what they can do. Furthermore, imposed identity cannot last forever. If categorisations such as Indigenous people, Africans, Americans, Europeans, Asians, White or Black people, Women, Men, Muslims, or Catholics are fixed, then we could not have the changes that we continue to have. For example, people who were called 'indigenous' in Mozambique and who were seen historically as the ones serving the colonialists are the ones ruling Mozambique at the moment. Likewise, assimilation, although set up to foster Portuguese culture, was used by Mozambicans to resist Portuguese colonialism. When out of the immediate influence of Portuguese, local people felt safe and often behaved more like Africans. This dilemma of living in two worlds in your own country was particularly true during the liberation war; it was also noticed by

Fanon (1970), for whom “every contact between the occupied and the occupier is a falsehood” (p. 50).

The war of liberation was another stimulus for Africans to change their attitudes towards the colonizer culture, at least in relation to the use of the majority of facilities introduced by the colonizer: schools and hospitals, Western knowledge, medicines, cars and clothes. The liberation war raised the need to quickly control the usage of these facilities because of their efficiency. In this process, the African culture did not remain the same, particularly the ‘indigenous’ identity found in colonial and Catholic discourse. One example is the colonizer’s language that was used by the colonialist to oppress, humiliate and insult the ‘natives’. With the onset of war the language acquired new significance. It was the only language (today it is still the same) that could be used all over the country for communication among people from different ethnic groups. Thus the colonizer language became a liberating instrument and the reluctance of learning the oppressor language largely vanished. The major implication is that this language was modified to allow the new users to express themselves. Indeed it was modified in terms of pronunciation, grammar and vocabulary, becoming in this way a cultural artefact (Fanon, 1970).

The war involved all members of society and therefore many relationships changed. For example, before the war marriages were arranged by parents; however, during and after the war girls struggled side by side with boys, and today they are the ones who present their relationships to their parents, usually with a first born as a present. In this process, the male voice loses its dominance and the female voice also loses its submissiveness (Fanon, 1970).

Indigenous knowledge expanded on the back of colonialism, but essentialists are interested only in so-called pure knowledge which has not yet been ‘contaminated’. This is a romanticisation of the concept of indigenous knowledge (Semali & Kincheloe, 1999). According to Hornby (2000), romanticisation means to make things more attractive or interesting than they really are and forbids development or change. My understanding is that indigenous knowledge is simply knowledge.

Knowledge can be defined as information, understanding and skills that are gained through education or experience aimed to help individuals to live in their environment (Hornby, 2000). Internal movements in Africa, colonialism and the liberation war constitute some of the stimuli to change indigenous knowledge and consequently local culture. However, essentialists are looking for pure culture. According to Semali (1999), it is not possible to find such kind of individuals because "all cultures (especially colonized ones) are perpetually in a state of change" (p. 22).

The notion of essentialism is underpinned (Semali & Kincheloe, 1999) by the belief that indigenous culture was influenced only by colonialism. For them this is a myth and they speak of the case of Australia where, before the arrival of Europeans, the Aboriginal people were influenced by Indonesians and vice versa. The same can be applied in Mozambique, as the area was settled by African internal immigration before the arrival of the colonial power (Forrest, 1996).

The notion of purity advocated by essentialists prohibits development of indigeneity, categorizing it as 'freedom/nature' and European culture as 'culture/reason'. These two knowledge systems, for essentialists, do not interact. Local knowledge is understood as primitive and as an important focus of academic knowledge, but never as the other kind of academic knowledge that can be studied at school.

After making explicit what I was feeling I was relieved for a time. It was true that my identity is not and cannot be fixed. If I was indigenous in the way that it is described by colonizers, I would never have learned the so-called Western science. Essentialism was serving colonial interests and I had overcome their barriers by being educated and educating myself. After these few moments of relief the storms came: Am I a colonizer by not allowing other knowledge than 'Western science' in the science classroom? What is my knowledge? How do I justify the inclusion of knowledge that exists within our many ethnic groups? My response is that I need to move to the next step (antithesis) in the triadic structure of dialectical thinking. In this step I need to avoid essentialism as it refuses changes in my identity.

Antithesis: My identity is always changing

Figure 4.6. Is my identity changing continuously?

Nonessentialism views culture as a dynamic process that can be observed differently by different observers: "The cultural position of the observer helps construct the description of such cultural dynamics" (Semali & Kincheloe, 1999, p. 23). The source of dynamism can be intra group, inter group (border crossing), or both. Individuals learn things from their culture and from other cultures and 'export' their knowledge to other cultures. This explains why no one is culturally pure and why all of us are absorbed in and participate in a subset of cultures (Erickson, 2004). Identities "are historically constructed, always in process, constantly dealing with intersections involving categories of status, religion, race, class and gender" (Semali & Kincheloe, 1999, p. 23). This is in contrast to the essentialist belief that there are fixed and stable identities. The tables below give a visualisation of essentialism and nonessentialism and their connections.

Identity is fixed (Essentialism)	**Identity is changing continuously** (Nonessentialism)
- Skin colour, place of birth, sex, religion determines undoubtedly our identity	- Skin colour, place of birth, sex, religion does not determine our identity
- The reality is explained by metanarrative	- Refuses metanarrative

Figure 4.7. Difference between essentialism and nonessentialism.

The immediate implication for the field of science education is that there is no reason to exclude any form of knowledge (science) from the science classroom as, according to the nonessentialist view, the world is explained by different knowledges all of which are equally limited and valid; hence my indigenous knowledge can and should be included in the science classroom. This stance is completely different from the one into which I have been educated and am teaching from, namely, that Western science is universally valid and provides responses for everything. If there is any event or phenomenon that does not have an explanation it is because scientists have not yet looked or they are still looking at that event or phenomenon.

For nonessentialists each knowledge system is constrained by its context and culture; hence, universal truth cannot be achieved. The first consequence of this proposition is that all knowledge at least in its initial stage of development could be considered local. Hence, 'local knowledge' can become 'global knowledge', as is happening with World Modern Science. I have reflected on this issue in Chapter Five but here I would like to argue that local and global knowledges, especially World Modern Science, are distinguishable by their locations.

In the context of Mozambique, the expression 'local' serves first and foremost the colonisers' interest of being distinct from native people. I cannot find an equivalent word in Changana. I understand 'local' as being attached to a certain place, in Changana we have expressions such as *vinhy va tiku* – (the owners of the land) and *vavandabwara* – (without land), the latter being an offensive term in my culture. I am calling your attention to the fact that from the native perspective, natives have the land, whereas from the coloniser perspective the opposite is true: the lands have natives.

Another of the colonisers' interest served by the expression 'local' is to show that colonizers brought with them an improvement to our lives; for example, better ways of teaching, moving and healing, and other forms of knowledge. Hence, all types of manoeuvres were made to reject indigenous knowledge; unfortunately this is still happening nowadays having as protagonists

compradors[5] and the hegemonic presence of colonizers (Ashcroft et al., 2000; Keniston & Hall, 1998; Yanow, 2004).

World Modern Science did not evolve simultaneously across the whole globe; rather, it developed at certain locations, and at that time it was local, just like other indigenous knowledge. Then the parts of that World Modern Science were joined, exported, imposed and developed, becoming in this way the property of human kind. It is not in my mind to say that World Modern Science belongs to every woman and man who exists on Earth: I claim that World Modern Science belongs to those who have been inducted into it. A highly visible group would be ('Western') science teachers and science teacher educators. This group of practitioners of World Modern Science exists all over the World. This was the fact that inspired me to designate this science as World Modern Science.

The development achieved by World Modern Science through the co-participation of women and men from all cultures throughout the world appeals and suggests that Mozambican indigenous knowledge needs to be included in the science classroom in order for it to be developed in a similar manner. But how do we do this without human resources and material? I see this as a challenge, not an impediment.

The second consequence of the proposition that "each knowledge system is constrained by its context and culture" is that the unique science we are teaching in the science classroom in Mozambique is valid within its cultural domain (i.e., World Modern Science) and its hegemony in Mozambique is given by being promoted at the expense of other cultures, especially local culture. In Mozambique the promotion of the culture of World Modern Science was done mainly by the colonial power (inside and outside of the science classroom), making sure that the natives hated their culture (see Chapter One). The culture of World Modern Science privileges a materialist causal rationality.

The imperialist form of promoting World Modern Science is covered by the altruistic slogan that they are giving others their way of pursuing the **Truth**

[5] Comprador is the local person who identifies with colonial values. S/he is interested in maintaining her/his social status and is not interested in changing the colonial system.

while eradicating the receiver's culture which does not lead to the **Truth**. In the words of Bilton et al. (2002):

> Modernity involved the pursuit of objective truth. Once armed with this truth, modernisers saw it as their duty to become missionaries – to oppose falsehoods. Thus, the standard bearers of science have marched against other forms of knowledge, crusaders on behalf of freedom from ignorance. (p. 433)

In Mozambique World Modern Science was brought by people from the West and probably because of this the dichotomic way of thinking promoted in the science classroom is seen as belonging to the West. I am questioning about how trustworthy is this view? Are all Western people thinking in the same way?

The expression 'local culture' is misleading as it gives that idea that one knowledge is operating at the world level while the other one is at the local level which can not be refused. I am arguing, however, that both knowledge systems were developed by people in certain places and times. Hence they are equally local or world wide. Furthermore, the categorisation of 'universal' or 'local' is not in the knowledge itself but resides in our view (should I say acceptance of that knowledge). My point is that the phenomenon of death, for example, which is explained in a certain way in Ndavene (a remote locale in Gaza – Mozambique) occurs all over the world but the explication that is given there has not yet been spread all over the world.

> … should we accept racism, sexism or religious intolerance by others in our culture? Should we have accepted the right of Hitler to exterminate the Jews, or of Stalin and Pol Pot to annihilate millions in order to achieve their political ends? Furthermore, does it mean that we have to accept the cultural and historical relativity of ourselves? Are we entirely at the mercy of social and cultural sources of identity, so that who we are and what we think is right or wrong are entirely a matter of chance? (Bilton et al., 2002, p. 435)

So for me the question arises: Is the contemporary promotion of World Modern Science in Mozambican science classrooms a continuation of the imperialism started by the colonial power? Imperialists affirm that Mozambique and other countries in the same situation pursue this form of scientific knowledge

because of its perceived superiority over indigenous knowledge (Bilton et al., 2002). Imperialists of knowledge employ an extremist argument against the principle of equity of cultures.

In this way, imperialists argue that different cultures should not be equally accepted because of the possible inequalities that they can incorporate. Although apparently sound, this argument does not address what is proposed by nonessentialism. Nonessentialism supports my proposal of giving equal value and status to different cultures and knowledges around the world. Racism, sexism, and religious intolerance exist within and among all cultures. The question, in my opinion, is not the acceptance of those awful aspects but how we make them explicit without replacing the local culture by an imposed one. The acceptance of all epistemologies would emphasize that all are valid and can contribute in different ways to general well being.

Figure 4.8. Can we accept in the same way cultural differences?

My understanding of nonessentialism supports what is happening in Mozambique, where the ethnicity is mixed in such a way that couples from different ethnic groups are the norm rather than the exception. Nonessentialism affirms that this is good because each of us Mozambicans is exposed to different knowledges, habits and customs, and that we need to understand that the world does not end at the end of our garden. One of the consequences of being exposed to different cultures is that we can go beyond the end of that garden if we wish. Probably this is what

Machel (1985) meant when he said “We killed the tribe to give birth to the nation. This [Mozambique] is not a nation of tribes, it is not a nation of races” (pp. 77, 78).

I am questioning how many of us in Mozambique see this healthy and peaceful amalgamation of ethnic groups as a source for ‘international’ and ‘universal’ values for our education system. It seems to me that when each of us decides that it is good to know more than one language, s/he opts for English, French, Spanish and German or other European languages instead of one of the languages of our ethnic groups. According to nonessentialism Mozambican languages are not chosen because of our (Mozambican) alienation from our own culture.

The inclusion of knowledge incorporated in the different ethnic groups that exist in Mozambique can help to challenge students and teachers to analyse the ethics inherent in that knowledge, the power relationships in our ethnic groups, and the manifestation of neo-colonialism (see Chapter Five) throughout Mozambique. In this way, local knowledge can help to address the issue of social justice in our society and can help each of us to be proud of his/her identity.

Identity (Golmohamad, 2004) is characterised by the way that things such as family, religion, political agency, education and human rights have significance for the individual as self connected to human aspirations in a given space. In other words, my way of teaching science and taking care of my family, for example, identifies me when it makes sense also to my local community. This way of teaching science and taking care of family is likely replicated elsewhere. Hence, despite my colour and location I can be characterised in the same way as people having different colour and locations from mine.

Sfard and Prusak (2005) suggest that our identities can be known by the stories told by individuals. For them, identity results from everyday interactions and decisions taken in everyday life. This notion of identity states that “human beings are active agents who play decisive roles in determining the dynamics of social life and in shaping individual activities” (p. 15). This notion of identity can help to unravel how the processes of failing or succeeding occur in school.

> People tell others who they are, but even more importantly, they tell themselves and they try to act as though they are who they say they are. These self-understandings, especially those with strong emotional resonance for the teller, are what we refer to as identities. (p. 16)

However, the weakness of this definition is that only the individual can characterise him or herself. A number of elements (including grades, test results, certificates, passports, diagnoses, licenses, diplomas, titles and ranks) are available to tell others who the individual is. However, even this alternative does not seem to be adequate for describing identity because of its reductionism (Golmohamad, 2004; Sfard & Prusak, 2005).

Nonessentialists view each identity on the planet as changing systematically. The identity of each of us is changing because in every single moment we are acquiring new experience/knowledge through what we see, think or learn in, for example, the science classroom; consequently, it is possible for different people to acquire the same identity. It does not matter where you were born - Africa, Europe or Asia - you have a certain identity according to the value that you place on things. This identity changes simultaneously with your change in referred values.

Nonessentialism agrees with essentialism in relation to the existence of characteristics that identify individuals, people and communities but refuses the immutability of these characteristics. For me this theory explains why individuals, people and communities change their opinion about different issues throughout their lives. It explains also why foreigners can become Mozambicans, to fight and die for the development of our country. Nonessentialism also explains the ongoing stability of our (evolving) mixed ethnic groups which, for me, is an example of how different people can live together.

However, nonessentialism creates the dilemma of accepting or rejecting its tenets. On the one hand, it frees me from the colonial fossilization of calling me ‘indigenous’ and allows me to bring into the science classroom knowledges other than the so-called Western science and to analyse and find out what are the

inequalities in my community. On the other hand, it affirms that 'I am changing continuously'. How can it be so, as I feel that I am still the same and everyone who knows me recognises me. I am sure I can accept discreet changes but perpetual change suggests the revolting idea of permanent unsustainability. These feelings of unease notwithstanding, I can not identify any contradiction within nonessentialism, only some questions that I could not answer by applying this theory:

(1) What makes me motivated to change from one identity to another, considering that both are equally acceptable?
(2) How many identities do I have?
(3) If I am changing from one identity to another, I am assuming in all of them a different status; so, are there preferred identities?
(4) Given that identities are different, does it make sense to segregate and classify people?

Therefore, I proceed with my dialectical thinking, aiming to answer those questions and to resolve the dilemma of permanent unsustainability. The synthesis in the triadic structure could be 'non/essentialism'. I use the 'slash' in the term 'non/essentialism' to denote the dialectical relationship between nonessentialism and essentialism. My understanding of non/essentialism is that I am moving back and forth strategically (Ashcroft et al., 2000) between nonessentialism and essentialism.

Synthesis: My identity sometimes changes

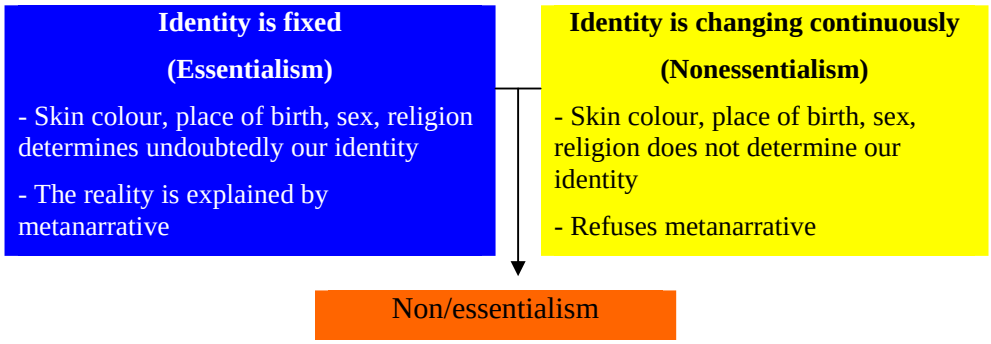

Figure 4.9. Non/essentialism as a symbiosis between essentialism and nonessentialism.

Non/essentialism is the symbiosis between essentialism and nonessentialism. Non/essentialism is 'strategic' essentialism because, as I will argue (using the concept of 'teacher' in an essentialist way), many interests for the individual and society can only be satisfied by using an essentialist concept of identity. Examples of interests satisfied by acting strategically in accordance with an essentialist perspective include both the expansion of imperialism and the war of liberation wherein each group assumed the fixed identity of 'exploiter' or 'exploited'. At the individual level, this included what to eat, what to do, and how to live in an environment. According to Ashcroft, Griffiths and Tiffin (2000), strategic essentialism has been used by National Liberation theorists such as Fanon, Cabral and James.

Figure 4.10. I am a factor of changing my identity.

Non/essentialism asserts that there exists a set of characteristics that identify individuals, ethnic groups and communities but also asserts that these characteristics are not fixed. Changes to these characteristics vary from individual to individual hence, although some exceptions occur, individuals are different from one another. Nevertheless, within a community all individuals share the same rights and obligations. The differences among individuals problematize firmly established concepts such as Africans, Europeans, Colonisers, Colonised

and Ethnic group. I agree with Preis (2002) who argues that homogeneity[6], which is often implied when referring to a given culture, does not exist.

This mutability suggests that individuals and groups can move back and forth between various ethnic groups and communities, within and outside of their countries. It explains also why individuals, ethnic groups and communities do not hold always the same view about themselves and the world around them.

According to non/essentialism, each identity that exists in Mozambique results from a 'cultural hybridity[7]' that we have both within and outside our ethnic groups. This is also shown by Mozambican history of being colonized and, prior to that, by the settlement of Africans in the territory now known as Mozambique (Forrest, 1996; Silva, 1998). However, our identities differ because we do not make identical sense of our experiences; like others, our identities "[are] actively constituted and negotiated" (Bilton et al., 2002, p. 182). In this way all individuals are indigenous. Each of us was born in a given place and all of us in the end are dependent on Nature. Furthermore, colour, gender, age, location of birth, class, race, religion, language, and spirituality are not adequate for distinguishing people, because identity is not limited to these dimensions. In the literature confluence of different identities is called 'cultural hybridity'.

Non/essentialist theory helps me to make sense of the concept of 'cultural hybridity'. This concept has created emotional and never ending debates because in order to fully understand it requires us to resolve dichotomies such as 'local/universal' and 'I/other'. However, these binaries raise complex issues that cannot be resolved by dichotomous thinking. Nevertheless, these binaries can be resolved if we promote a dialectical co-existence of different cultures in hybrid space (Bhabha, 1994; Tobin, 2007).

According to non/essentialism, when individuals, ethnic groups and communities are comfortable with their identity this constitutes their essence; consequently, they can be characterised by a set of determining features. When

[6] with all members of that culture thinking and doing things exactly in the same way

[7] I understand cultural hybridity as resulting from interaction among people that can belong to the same community or ethnic group. Hence, in all of our interactions we are creating a third space because we do not have exactly the same culture.

they change, their identities simply move strategically to another essentialistic identity. In this way non/essentialism is based on individual agency. For example, it affirms that we (Mozambicans) perceived the identity imposed by the colonial power (essentialism), then we refused it (nonessentialism) and then we assumed the identity of the exploited (strategic essentialism or non/essentialism).

Non/essentialists accept that in Mozambique we have strongly interconnected groups and, consequently, we have a multicultural setting where each culture is evolving gradually, rather than every single second as implied by nonessentialism. For non/essentialists, indigenous knowledge should be one of the referents in the teaching process as a way of deepening the understanding of our context and the relationship that we have with the rest of the world. Another justification to include indigenous culture in the science classroom is because culture differs from ethnic group to ethnic group and from place to place. Students should be, first of all, informed about different cultures and, secondly, helped to move from one culture to another if they want to. Hence, some of the roles of indigenous knowledge in education can be:

(1) to contribute to students being well informed and able to make informed decisions about their life;

(2) in Mozambique, to enable students to see what they have in common as well as their differences; and

(3) to understand science from a wide perspective.

Non/essentialism also explains why the unrealistic teaching of science that does not have connection with our own lives has a success that is shown by me, my colleagues and students. We have assumed that we are ignorant (essentialism), we want to be informed (nonessentialism) and we have mastered through more/less memorization and Fatima's rule. We imagine living in a perfect world where scientific principles and laws are valid (strategic essentialism). The problem is that when we wake up from the imagined world we are lost in this other world: the world outside of the science classroom where I need to apply force to have a motion with constant speed in a straight line and I use mass (kg) to refer to weight (N). This is also the reason for this thesis.

In this way, non/essentialism helps me to understand that my identities exist (essentialism) and are changing (nonessentialism) gradually (non/essentialism). Non/essentialism also helps me to contemplate why I should include indigenous knowledge in Mozambique. Non/essentialism helps me to understand that 'indigenous' is a category created by essentialists that I can use for my own interests. Non/essentialism is formed by two opposites: essentialism and nonessentialism. How do I distinguish the concepts of essentialism, nonessentialism and non/essentialism?

Essentialism and nonessentialism are the binary opposites[8] with which my understanding evolved using dialectical thinking. My changing of identity is explained by non/essentialism. According to essentialism, individuals, ethnic groups and communities can be identified using a fixed set of characteristics. As those characteristics are immutable, we can distinguish and segregate individuals, ethnic groups and communities. For nonessentialism, this condition does not exist, while non/essentialism balances the two extremes.

I have finished using the triadic structure of dialectic thinking. At this stage, I should be able to answer and know the implications for science teacher education of the question 'who am I?'. Although I have not yet fully answered the question the process of applying the triadic structure has enabled me to outline some of the implications of the question 'who am I?'. The main implication for science teaching is that, as a science teacher educator, I should include indigenous themes in my classroom, aware that I am not just repeating what I learned from my colonial education.

In relation to the term 'indigenous' I have concluded that the colonizers and colonized and, by extension, all individuals worldwide are indigenous. At the end of the day, we were born in a given place and have habits and customs that are peculiar to others. There is nothing inherently wrong with or to be ashamed of being indigenous. This stance represents a new way of viewing my identity. Before, when I was ashamed of being indigenous, I used to think that indigenous

[8] See the meaning of opposites in the glossary.

people lived in the countryside and not in cities ruled in general by the Western style of living.

In my old view, I am indigenous when I am in the countryside eating the food cooked by my grandmother, speaking my mother tongue (Changana), educating ourselves and the youth through stories, and discussing where to start to collect cashew nuts: this is living the life of my ethnic group. And I am not indigenous when I am in the city educating about the teaching of World Modern Science, perhaps because all of us in the city cannot relate to this other life easily, based on what we are doing and where we are now. And if I am a father at home when I am taking care of my children, I am not a father at the hospital when I queue to see a nurse. And if I am Changana within my ethnic group, I am not Changana when I learn Macua habits and traditions. The main problem with this old view is that it compels me to be independent within each of the possible identities: Changana, teacher, father or patient. But this never happened; I found that I could play well my role in each of these identities when I was aware that I did not have problems to solve in other identities. I have solved the contradiction of being independent in each identity while assuming responsibilities in others by thinking that it does not matter what I am doing or where I am: I am the same.


Figure 4.11. Am I always the same?

My new view of identity helps to explain the existence of two types of identity - fixed and changeable identity - but does not help to explain the feeling of being the same. Is this a limitation of essentialism, nonessentialism and non/essentialism or is there a failure in the use of the triadic structure of dialectical thinking? What is the importance of explaining the feeling of being the same in the field of science education? In Mozambique, it is important because, in this way, I see that the Maconde, Machangana, Macua ethnic groups, just to name a few, and consequently, Maconde Knowledge, Machangana Knowledge, Macua Knowledge

and, by extension, Western Knowledge are fictitious constructions. What we have are human beings born in certain contexts and cultures, which does not make them the owners of those contexts and cultures; furthermore, those human beings can decide to live in a sustainable way wherever they want to and science education can contribute to their purpose if designed with that purpose in mind.

I realise, looking at essentialism, nonessentialism and non/essentialism, that the focus is on changes in identity or, more precisely, on how the characteristics of identities change. So, as a triad these theories do not help me to elicit what identifies me; the focus is on change and not on emergence of identities.

How do I explain who I am if essentialism, nonessentialism and non/essentialism cannot help me? While I was wondering about this, BalChandra (Bal), a colleague of mine presented the theories that he would like to include in his thesis. He referred to nondualism. It was a 'strange' theory for me. Asking what it meant, Emilia's (at the moment we are three researchers in culture studies with our mentor Peter Taylor) answer was that it means, for example, the absence of binary opposites such as matter and spirit, left and right, or right and wrong.

I decided to research 'nondualism' to see to what extent it could help me to understand who I am. My experience with 'essentialism' led me to decide that 'non/dualism' could the operational level between 'dualism' and 'nondualism'; in other words, non/dualism expresses the dialectical relationship between nondualism and dualism.

Using Non/dualism to Understand My Identity

Dualism

Dualism or Cartesian dualism (Hornby, 2000; Lowe, 2006; Reed, 1997) is a theory advocating the existence of two opposites in everything.

Everything in the world is the manifestation of one of its two opposites (Dualism)

Figure 4.12. Characteristic of dualism.

Those opposites can be analytic/synthetic, cause/effect, creator/created, mind/body, father/non-father and teacher/non-teacher, just to name a few. How does dualism help me to know who I am?

I understand dualism as the theory that allows me to assume any identity but this identity will also be attached to its opposite. In this way dualism is similar to essentialism, nonessentialism and non/essentialism as both focus on change. The development of the essentialist view in dualism is that for every identity assumed its opposite is attached. For example, if I behave as a Machangana, this means that I am not behaving as a member of other ethnic groups that exist in Mozambique and, consequently, in the rest of the world. And if I behave as a teacher I suppress in me everything that does not help me to teach.

In the field of education, dualism supports the teaching of different identities such as exists in Mozambican contexts and the teaching of different entities as independent units. My role under the dualist perspective is to teach students the obligations and privileges attached to each one of my possible identities and views of the world.

The main advantage of dualist theory is that it satisfies the needs of s/he who is using it. Apparently, an entity, facing any need, responds from a dualistic perspective: when we want food, transport or to communicate, we assume the dual identity that can get those things.

It seems to me that there are two major limitations of a dualistic identity. The first is to accept that everything exists, since it is linked to its opposite. In this way, I can be Changana, Black, White or something else since each ‘status’ is linked to its opposite. In this way, dualism can be equated to one of the principles of thermodynamics stating that all phenomena that do not create or destroy energy are possible (*perpetuum mobile*), a concept that is elusive (de Rosnay, 1998; Nikulov, 1999). The elusiveness of dualism is that I can adopt any citizenship but I cannot change my ‘black’ skin. Second, the division of the world into two opposites assumes that in each there are uniformities and that they exclude or oppose that which does not correspond to the truth. For me, it is not true that when I behave as a Machangana my feelings can be distinguished from the feelings

experienced by other people in all other ethnic groups. However, dualism suggests that I experience different feelings when I acquire the different identities that exist in different ethnic groups in Mozambique.

Dualism tells me that I have the power or ability to suppress and make alive parts of myself when I behave as father, mother, teacher, Machangana or something else. I do not agree with this perspective largely because I see myself as whole in every single attitude or gesture.

Dualism explains many of the troubles that we went through during the colonial time and (un)willingly we continue to perpetuate in our postcolonial era, through our education system. Colonialism can be understood as one possible misuse of dualism: as I am distinct from others and they do not participate in my identity their existence restrains my space and constitutes a hindrance to my ability to distinguish myself.

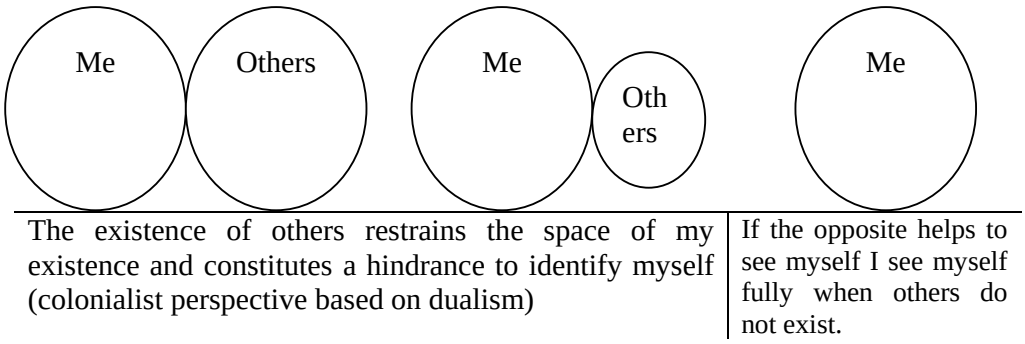

Figure 4.13. Implications of dualism.

Hence, we (colonizers) need to make them (colonized) assimilate (see Chapter Five) our perspective and become ourselves or to eliminate them. In Fitzsimmons (1987) words:

> (1) The inherent consequences of a dichotomous ontology are both unattractive and inauspicious. The division of being into arbitrary categories of sacred and profane, sentient and nonsentient, living and mechanical, or even into the attributes of thought and extension, (2) harbors an incipient adversariality which manifests itself as a pervasive devaluation of at least half of being. Because this position implies (in practice if not in principle) prejudice toward the "other,"

> the devalued, the "lesser" of the pair, it seeks to destroy that which it omits from its own category, both in the whole of being and in the person of the severer. (3) Hence holocausts, prisons, ghettos, mental institutions, wars, hunger, damnation and the state. Dualism bestows upon us taverns and churches, ladies and whores, heavens and hells. This is the penalty of the knowledge of good and evil. This is life and death after the fall. (p. 2)

I conclude that the advantage given by dualism can be achieved when it is used in its moderate form and this should be done in such a way as to avoid the excess that Mozambicans and the rest of the world have been through. Dualism helps me to differentiate myself (a) in my many identities and (b) in relation to others, but does not help me to know who I am.

Nondualism

Nondualism or a non-Cartesian substance dualism (Lowe, 2006) refuses the trustworthiness of the dualist/dichotomic view of the world by stating that mind and matter and knower and known are intimately related.

It is not possible to separate the components that form the world (Nondualism)

Figure 4.14. One of the characteristics of nondualism.

How does nondualism help me to know who I am? My identity used to be son, man, Black – sometimes 'black' (see Glossary), student, Mozambican, teacher and other things that I know about myself. Today, I understand these multiple dualistic identities as concepts, ideas, categories, beliefs and sentiments that I am aware of but - none of them is Me. They constitute a list of what I am not because I am the one who sees those identities and is aware of them. I am Awareness or Seer (Wilber, 2000).

The Awareness or Seer, also called Witness or Emptiness, can be compared with a special Container that is aware of itself, of what is inside, and of what is outside. The Container or its parts cannot be seen: It is not an object. Whatever can be seen (thoughts, feelings, reactions, objects) is not the Container but objects. This Container is so big that it can contain all objects at the same time.

The objects are moving constantly from the outside to the inside of the Container simultaneously. How big is this Container? It is considered to be the "vast sense of freedom, that vast Emptiness, that vast opening, through which manifestations arise, stay a bit, and go" (Wilber, 2000, p. 201).

> Things arise in awareness, they stay a bit and depart, they come and they go. They arise in space, they move in time. But the pure Witness does not come and go. It does not arise in space, it does not move in time. It is as it is; it is ever-present and unvarying. It is not an object out there, so it never enters the stream of time, of space, of birth, of death. Those are all experiences, all objects-they all come, they all go. But you do not come and go; you do not enter that stream; you are aware of all that, so you are not caught in all that. The Witness is aware of space, aware of time-and is therefore itself free of space, free of time. It is timeless and spaceless–the purest Emptiness through which time and space parade. (Wilber, 2000, p. 202)

In nondualism, expressions such as 'I' and 'you' do not make sense because, if on the one hand, Emptiness can be characterised as the Seer or Witness, on the other hand Emptiness is everything that can be witnessed or seen. It is not "a particular state *apart* from other states, but the reality or condition of *all* states, high or low, sacred or profane, ordinary or extraordinary" (Wilber, 2000, p. 206).

The impediment of using 'I' and 'you' echoes with how I see myself. I need to tell you how I understand myself in a nondualistic perspective, but this is a dual act; hence, what follows will necessarily be an approximation of my intent. I see myself as the result, product and/or builder of my people, land, history and feelings.

I do not believe that by suppressing our culture in our education system we are educating ourselves and our people, because culture, as other elements that surround humans, is part of identity. Although Nondualism is helpful to see myself in full, 'non/dualism' mediates between dualism and nondualism to enable me to concentrate on different aspects of my identity.

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Figure 4.15. Mozambican Students.

Non/dualism

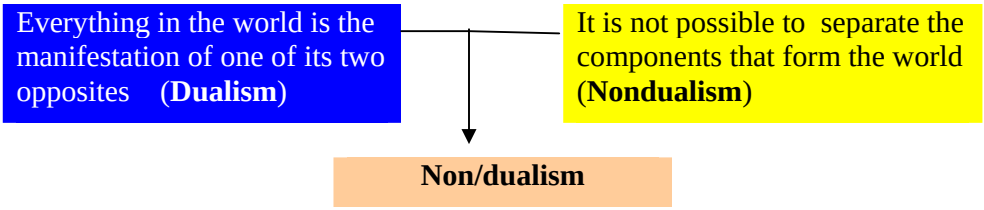

Figure 4.16. Non/dualism as a symbiosis between dualism and nondualism.

Non/dualism allows me to have any identity that is not two sided, in fact it is the merging of those two opposites. Using non/dualism I can affirm that my identity is me and it determines how I interact with students that have different backgrounds in the environment where we are. This identity reflects my physical and spiritual being. Thus, it shows that I am the One who was born and went through all my experiences with strengths and weaknesses; the One who wants to understand himself in order to be with others and exercise his educator profession.

Non/dualism affirms that, although acceptable, essentialism, nonessentialism, non/essentialism and dualism, attempt to characterise human beings by non-human characteristics. In those theories, we select a few non-

human attributes, such as profession, abilities, place of birth and relationships, to characterize ourselves. However, in every single moment of our lives we are characterized by more elements than we are (un)aware of. Hence, our identity is our consciousness/awareness. This is the identity that I would like to offer to my students in the science classroom.

Today, I realise that essentialism, nonessentialism, non/essentialism and Dualism refer to my pseudo-identity. According to these four theories, there are many identities: for the first one, each of us has just one identity; for the second, we assume one identity after another; for the third, the change of identity is not continuous; and for the last, our identity is a manifestation of one of the two blended opposites. According to non/essentialism and dualism in general we remain in one identity until we are motivated to move on. The inconsistency in these views is, for me, that in all those identities I am still the same while different. Non/dualism resolves this inconsistency by saying that I am always the same. I am just wearing any convenient identity to perform my duties and wishes. Thus, non/dualism solves the limitations of essentialism, nonessentialism, non/essentialism that are derived from their attempt to match ideas, concepts, desires and feelings with the Self who is aware of them. Essentialism and non/essentialism characterize the Self by colour, gender, age, location of birth, class, race, religion, language and spirituality, giving in this way a false identity of the Self. I have found it to be more meaningful to consider Wilber's (2000) concept of identity of the Self as the One who is aware of himself/herself and what surrounds him/her.

How Non/dualism Applies to My Colonial and Postcolonial Situation

a) At a personal level

At a personal level, non/dualism helps me to know better who I am: now I can tell how wrongly I was characterized by essentialists as indigenous, African, colonized, teacher, husband, researcher, father, or something else. In fact, I am none of these categories, which were created to serve, in many cases, other

interests. I am the One who is aware of these efforts to achieve both my own and others' interests. I am Awareness. I am a vast space where things can come, go, or stay forever.

After this work, I see the essentialists' categories mentioned above as metaphors that aim to serve different interests. For example, if someone tells me that s/he is a teacher, I will understand this as a description of what s/he does or needs: (a) books, (b) ways of dealing with different people every year, (c) a belief that people can change, and (d) a belief that other people could not become what they are if not for the teacher. Nevertheless, I will have peace of mind knowing that s/he is neither 'teacher' nor other things that s/he could list because s/he is just the Awareness of these things. However, all of us 'need' to assume strategically (Ashcroft et al., 2000) these 'false' identities; otherwise, how could we satisfy our needs?

The essentialist identities that we assume are false because they try to match things and human beings. Considering the previous example of teacher, we can understand that this category can mean the skill to teach, but that skill cannot be a person. The person remains a person, Awareness and Emptiness, from the beginning until the end, if there is a beginning and an end. Is there any fallacy in this reasoning?

I need to distinguish between dualistic identity and Awareness. From now on, I will use the term 'identity' to refer to the essentialist notion of identity – the identity used to distinguish ourselves in relation to our skills and to achieve designated interests.

b) Implications for science education

The formation of identity is personal but, at the same time, it is universal because it always involves people. Thus, we can share our experience of learning and others can understand us. Among these 'others' some were part of our experience or went through a similar experience.

Non/dualism (Wilber, 2000) tells me that what happened and what is happening will never characterize my identity. This will be my history that I need

to use critically to understand my setting. In other words, Mozambican schools before and after independence have not been helping students with their cultural identity. Teachers in schools are exposing students to whatever is desirable according to the era in which they are working. However, the acceptance of what has been taught in schools depends on students' agency. My experience as a Mozambican tells me that identity is also shaped by the environment, particularly in schools. When this environment imposes upon individuals a false identity it can generate a revolution or radical self-determination. Perhaps this explains why young people in Mozambican schools are choosing not to participate in or to underachieve in school science.

Applying non/dualism to my former student-teachers who are not applying Locally Available Materials Technique in their teaching (see Chapter Three) I conclude that the applications of locally available material depend also on their decision and not exclusively on what happened in our science classroom.

Summary of the Chapter

Figure 4.17. Indigenous knowledge should be relevant to the school's location.

I started this chapter looking at my own identity as a contribution to answer the specific research question 2: What are key opportunities and obstacles to making science teaching relevant to everyday life in Mozambique? At the end of the

chapter I comprehend that I went through this process because this question refers to certain people in their everyday life. Now I know how I can characterise those people.

My hope before starting this chapter (see Chapter Three) can be summarised as ‘by knowing who we (Mozambicans) are, I will necessarily know my culture and empower my students. I realise now that I know who my people and I are and how our culture can be promoted, but I still need to clarify the concept of culture and why I advocate its promotion by being included in the Mozambican science classroom (see next Chapter Five).

In relation to the empowerment of my students, my conclusion that I can not experience nondualism tells me that I can also choose which aspects to develop but not all their skills and identity at once. This should be seen not as a product but as a process that we will be in, moving towards a perfection that we will never achieve (the learning continues after school). Teachers need to be able to express their assumptions and beliefs, respect students’ beliefs and assumptions, and work closely to achieve various interests. They should also recognize that people have strengths and weaknesses, and develop systems to diminish these weaknesses. What can be seen as a strength and works with one student can be a weakness and does not work with another, and vice-versa. It is not possible to reach the stage where the teacher has collected all the strategies of working with students, because all students are different and are constantly changing as they develop. I agree that, in this process, it is possible to develop principles, but the application of those principles will challenge, in each case, teachers’ imagination.

I have gained a better understanding of having Mozambican schools promote a Mozambican culture which gives ‘true’ Mozambican identity. I started this chapter thinking that my identity has evolved largely by means of imposition by different curricula in distinct periods of Mozambican society. I finish now knowing that, although in some periods there was coercion to assume certain identities, I have now assumed the One that I wanted to be through the realisation of my own agency.

In the process of searching for my identity, I have included consideration of how schools have been used to foster 'identities'. An essentialist view of identity was the first stage of my search. The second was non/essentialism, and the final one was non/dualism within a dialectical thinking process. According to non/dualism, I am the one who chooses the 'identity' that I want to have but this chosen identity is not the One who I am. In response, I have constructed a poem titled 'I am the one who I am' that can be found at the end of this thesis (see Chapter Seven).

One of the outcomes of this chapter is the justification of including Mozambican knowledge in the science classroom; as I have argued local-indigenous knowledge, like other knowledge systems, is local. In a large and culturally diverse country like Mozambique it will be very difficult to integrate indigenous knowledge into the national education system. My hope is that well trained teachers will investigate and incorporate indigenous knowledge into their teaching. However, the major curriculum restraint to integrating indigenous knowledge is that "teachers and students operate in a context that isolates practitioners, mutes autonomy, and pushes for standardization and homogenization embedded in relations of power" (González, 2004, p. 23).

Local-knowledge is one of the characteristics that I have and it should be included in the science classroom. How trustworthy is it to say that by doing so schools will be contributing to making science teaching relevant to everyday life in Mozambique? My difficulties in answering this question come from my perception of culture. How do I define Mozambican culture? Why is the inclusion of that culture in the science classroom one condition for its development? I address this question in the next chapter (Chapter Five).

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Chapter Five: Mozambican Culture in the Science Classroom

Introduction

> *Ours is essentially a tragic age, so we refuse to take it tragically. The cataclysm has happened, we among the ruins, we start to build up little habitats, to have little hopes. It is rather hard work: there is no smooth road to the future: but we go round, or scramble over the obstacles. We've got to live, no matter how many skies have fallen.* (Lawrence quoted in Bilton et al., 2002)

Figure 5.1. The burst banks of the Zambezi River in Mozambique.

The Mozambican situation can be characterised by several calamities we have been through: floods, draughts, landmines, colonialism and civil war. Our moments of peace have been ephemeral because if we are not suffering directly from any one calamity we do suffer from the effects of those calamities. In this situation we do not have a choice other than to (re)build our lives but, I ask myself: (a) Are we rebuilding just to replace what has been destroyed by those calamities? (b) Do we take into account the catastrophe itself and (re)build a new life? To take into account means to understand the causes and effects of that calamity so the next calamity can be avoided or will not appear exactly in the same way that the last one appeared. How do we address other catastrophes that are happening in our everyday life? I have called your attention to our (Mozambican) life because specific research question 2 is stated in terms of everyday life.

I have discovered 'myself' in the previous chapters. It happened while I was (re)constructing my journey as an individual, learner and teacher in Mozambique by deriving non/essentialist and non/dualist perspectives with the help of dialectical thinking and postcolonial theory. The newly enriched understanding of my cultural self reinforces my standpoint that to be decolonized, to comprehend the hegemonic forces, habits and customs that drive science education in Mozambique, it is necessary to include Mozambican culture in the science classroom. The impact of including Mozambican culture in the science classroom is twofold. On one side, Mozambican culture will contribute to our decolonization and work against neo-colonialism which is a subtle form of colonization[1] (Ashcroft et al., 2000). On the other side, Mozambican culture will develop further.

What is culture? What is Mozambican culture? Education is by nature a cultural activity. If culture is not incorporated into the education process, then the interests of students, teachers and the community where the school is located cannot be well served. Given that premise, I now consider the concept of culture and its connection with science and knowledge and how culture shapes the education process.

This search for how to decolonize and how to promote Mozambican culture in the science classroom, that is illuminated by postcolonial theory, includes concepts of *multiscience education*, the *universality of World Modern Science*, *indigenous science*, *culture* and *Mozambican national identity*. The search is guided by specific research question 2: What are key opportunities and obstacles to making science teaching relevant to everyday life in Mozambique?

Understanding Postcolonial Theory

Postcolonial theory suggests that reflecting critically on the way that I have been accustomed to teaching and educating science teachers can be culturally emancipating for all of us; that is, emancipation in the sense of not being ashamed

[1] one manifestation of neo-colonialism is called *comprador* (Ashcroft, Griffiths, & Tiffin, 2000). Compradors are natives who assume colonial values.

of my practices outside of the science classroom, being able to analyse the same practices, and to exchange practices with my colleagues.

I started my walk towards cultural emancipation with the adoption of Locally Available Materials Technique that was emphasized by Professor Gau (see Chapter Three). This approach, however, was initiated before the arrival of Professor Gau at Pedagogical University; indeed, I was invited by one of my lecturer's Baloi to join a team inquiring about hunting's indigenous techniques and understanding. Our goal was to build models for teaching concepts from World Modern Science. This inquiry involved selecting materials and building traps, setting up traps and catching animals (Baloi, Matonse, & Simao, 1994). I reflected on Locally Available Materials Technique in my Masters Degree where I labelled them 'Free-hand experiments' (Cupane, 2003); they are 'simple' experiments that use everyday or locally available materials and involve low cost. Locally Available Materials Technique has the great potential of allowing alternatives to traditional methods of teaching. Today I realise that I used these experiments to bring students' contexts into my teaching of World Modern Science (see Chapter Four). In my Masters Degree, my message was that Locally Available Materials Technique represented a potential way of including our culture in the teaching/learning process. Now, I realise that this potentiality could not occur primarily because the curriculum framework as it stands in Mozambique is dedicated to teaching World Modern Science. Probably this explains why my student–teachers did not change their traditional teacher-centred ways of teaching even after being exposed to Locally Available Materials Technique. For them, Locally Available Materials Technique represented a difficult way of doing what has been done traditionally: transmitting scientific knowledge.

An easy conclusion could be that *to change the curriculum in order to teach more than World Modern Science* requires changing the central focus of teaching, from the *teacher* to the *students*, with the help of Locally Available Materials Technique. But my hope with the adoption of Locally Available Materials Technique was to go beyond transforming a student-centred educational process. My expectation was to see schools contributing to the transformation of

society, and vice versa. This ‘transformation’ could be, for example, making the society aware of its routines in cooking, collecting and preserving water, other habits involved in our relationships, including initiation rites, and the advantages included in these procedures.

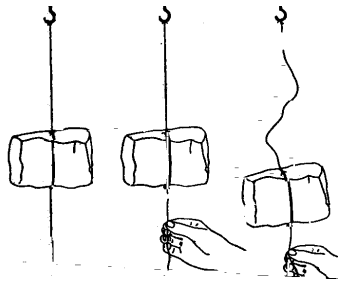


Figure 5.2.

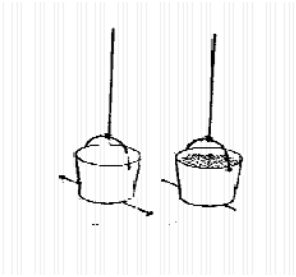


Figure 5.3.

Figure 5.4.

Examples of Locally Available Materials Technique for studying inertia and how to feed Kangaroos

I do believe that some transformations in our curriculum are pre-requisites for making possible the achievement of my goals with Locally Available Materials Technique and I am dedicating Chapter Six to this issue. However, even without curriculum reform, each of us who feels the need to bring indigenous culture into the science classroom could still attempt to do so. Is this not happening largely because we were educated in the same way that has been used for centuries and our habits, beliefs and traditions are not constructed or dismissed in one day?

Mozambique was under a colonial system for nearly 500 years. During that period, school was one of the places where we felt that we did not have independence. Independence can be understood as lack of political and economic

restrictions. Independent people can organize their own life and in that way make their own decisions (Hornby, 2000).

We brought to our independence the legacy of being dependent on a colonial power. The war of liberation required a lot of discipline from participants (*discipline* should be understood as lack of initiative) and immediately after independence all Mozambicans saw themselves as soldiers participating in the war of liberation. Soldiers by nature are dependent on orders. This was shown by the volunteer work done by everyone, everywhere, all the time. People massively participated passionately in long meetings to make consensual decisions. The level of criminality nearly decreased to zero. Everyone was possessed by fear of being connected with behaviour that was not sanctioned by the ruling party (Couto, 2006).

The lack of initiatives in the field of education shows that 'dependence' is one of the hegemonic forces that continues to drive the education process in Mozambique. One manifestation of this hegemonic force is that although we complain about the hateful curriculum that we learn we are continuing to use the same curriculum, simply replacing colonial by Mozambican examples. An excuse is that the hated curriculum was a successful process as it helped in the training of people like me.

The language and content taught at school were strange for us during the colonial period. However, because this was done systematically some of us ended up learning what was taught. Mandela (1994) illustrates what I mean by systematically in the context of an extreme situation.

> In the midst of breakfast, the guards would yell, 'Val in! Val in!' ('Fall in! Fall in!'), and we would stand outside our cells for inspection. Each prisoner was required to have the three buttons of his khaki jacket properly buttoned. We were required to doff our hats as the warder walked by. If our buttons were undone, our hats unremoved, or our cells untidy, we were charged with a violation of the prison code and punished with either solitary confinement or the loss of meals. (p. 466)

In the colonial period many Mozambicans pretended to have assimilated Western concepts. This pretence was necessary in order to use facilities brought by the colonial power, such as schools and hospitals. For many Mozambicans, assimilation was experienced as a dilemma that dictated in many cases Fatima's[2] rule, seen as justification for perpetuating colonization. However, the percentage of the population willing to access colonizer facilities was insignificant compared with the majority of the population which turned its back on hospitals and schools.

> In all objectivity and in all humanity, it is a good thing that a technically advanced country benefits from its knowledge and the discoveries of its scientists. When the discipline considered concerns man's health, when its very principle is to ease pain, it is clear that no negative reaction can be justified. But the colonial situation is precisely such that it drives the colonized to appraise all the colonizer's contributions in a pejorative and absolute way. (Fanon, 1970, p. 102)

I have used in the previous pages postcolonial theory to understand "how [colonial] modes of representation work to create, maintain, and to extend hegemony" (Carter, 2004, p. 826). This is how I was acculturated into science education and to postulate how other people, including those from colonizer countries, have been dominated by a colonial (imperialist) view of knowledge. Why do I see postcolonial theory as useful and adequate to my study? What is postcolonial theory? Probably I was captured emotionally and intellectually by the title 'postcolonial' – emotionally because the immediate meaning of postcolonial is after colonial and the echo of this meaning in my mind is to cease the pain and subjugation. Intellectually it was because I am aware that colonialism did not end

> At this stage of my research I was not worried about the relationship between local-indigenous and World Modern Science. I was not aware of creating the dichotomy 'colonial/postcolonial' and how elusive is this dichotomy. For me it was necessary to create it in order to analyse it, I mean to analyse one of its parts; the part in which I am represented (Carter, 2004; McClintock, 1992).

[2] Fatima's rules are a set of strategies to hide that the learning process failed (Aikenhead, 1997, May May May).

at the date of our independence, so my hope was that this theory could help me to get rid of the vestiges of colonialism.

Postcolonial theory, as with other theories I am using in this chapter, was embraced by me to justify why Mozambican indigenous knowledge should be incorporated in the science classroom. However, according to (Carter, 2004), the choice of postcolonial theory is helpful because it does not only help me to justify the inclusion of indigenous knowledge but to question which science should be included and how to teach that science.

> Postcolonialism's ability to delve into these processes, and into the deeper ravines of referents like modernity, identity, representation, and resistance underpinning many theorizations of culture and difference including those used, but underexplored, within science education, can open spaces to generate different discussions about what science education is, and could be. (Carter, 2004, p. 821)

In this way, the scope of postcolonial theory includes the analyses of a new imperialism that can be seen in globalization; how individuals can identify and distinguish themselves through a complex notion of culture. The study of globalization in science education can be analysed in three perspectives: (a) identities/subjectivities of students and practitioners, (b) science as cultural location, and (c) others who do not fit into the previous two categories (Carter, 2004). My work fits in (a) and (b) categories. The first stands for the acknowledgement of students' background; hence they should be assisted in their struggle to cross the border (Aikenhead, 2001; Giroux, 1993) but, it should be a two-way border crossing. Secondly, my stand is that scientists from all over the world have created their own culture and that is distinguishable from all cultures that exist in the universe, including Western culture. So, my position is that the knowledge that exists in each culture on the planet should be allowed to be taught in the science classroom in parallel with World Modern Science, creating in this way a space characterised by the different ways (logics) of seeing the world.

The term 'postcolonial theory' originated with Edward Said's critique of European imperialism based on Fanon's anticolonial work. However, Said

focused on the forms that imperialists used to establish their hegemony while Fanon was concerned with the identity of the oppressed. The shift started by Said was continued with Bhabha and Appadurai, whereby diaspora transformed the world into a 'hybrid space' created by globalisation. Hence, postcolonialists focus on the definition of identity and representation in the actual era, fostering hybridity and ambivalence using social justice as referents in their work. This implies that in science education postcolonial theory cannot be limited to inside the classroom; in fact, it goes "beyond science education's conventional categories of analyses". The postcolonial reality analysed by postcolonial theory is not fixed hence the theory is changing on one hand as the result of researchers understanding and on the other hand as the result of transformation on the researched postcolonial reality (Carter, 2004, p. 825).

A key postcolonial perspective focuses on two things: how the colonizers make the colonized appear inferior (representation) and on the latter's attempts for emancipation (recuperation). Representation refers to how colonizers created a colonized image and imposed it on the colonized. Before the arrival of colonizers in Mozambique, I was not indigenous, but when they arrived I was forced to view myself through this category created by colonizers.

> The very constitution of [colonial] subjectivity depended upon the reciprocity expressed in identifiable binary opposites such as self/other, Western/indigenous native, scientific/non-scientific, culture/nature, logos/spirit and so on. (Carter, 2004, p. 826)

Figures 5.5 and 5.6. For colonial subjectivity we constitute a binary of opposites.

Postcolonial theory with the help of other postmodern theories (e.g. poststructuralism) deconstructs the assumption of seeing as natural the superiority of one over another. This superiority is affirmed through the notion that indigeneity represents one of the phases that colonizers went through previously. In this phase, the colonized were linked to the land and, consequently, were pure and inferior, while the colonizers were linked to industry and, hence, were developed and superior.

> Indigenous knowledge is placed on a timeline that precedes Western science, reaffirming Western science's superiority of historical progression so that the Other's still traditional present is the Western traditional past now lost, and the Western scientific present will be their future. In this manner, the binary relationship between Western science and indigenous knowledge is continually being (re)established and (re)presented. (Carter, 2004, p. 826)

Postcolonial theory helps colonized people to fight back for their rights, mainly by developing their "modes of representation and actively determining their own meanings" This is called 'recuperation' (Carter, 2004, p. 827). However, recuperation and representation are closely linked to a 'cultural translation' that can favour colonial representation and undermine the colonized's recuperation. Cultural translation is the way to maintain the violent and strange way used by the colonizer to describe the colonized by making it acceptable, familiar and predictable for the colonized.

Postcolonial theory is largely built on the concept of the 'other' with complex implications. One of the complexities brought by the concept of 'otherness' is that if the 'other' is the colonizer then it is possible to develop essentialist concepts (see Chapter Four for details) such as Black consciousness, Indian soul, Aboriginal culture and so forth. This essentialisation (Lye, 1997) is fuelled by the colonizers' intention to see their culture from a dominant perspective and the other culture as the one that needs to be conquered, civilized, and domesticated. However, the essentialization of the colonizers is false because Mozambicans, for example, are constituted by several ethnic groups; hence, although we can be 'other' from a colonial perspective, we have also differences

among us. Alternatively, if each of us sees the 'other' as the colonizer, then inequalities and injustices within and among our ethnic groups will remain unattended (Lye, 1997).

Another aspect of this complexity is that although each of us can analyse his/her situation in relation to others we are unreservedly and constantly changing; hence, our past may be dreamed of but cannot be brought back: 'You can't go home again'. Thus my aim is not to introduce Mozambican culture in the science classroom as it was before the arrival of colonialists but as a way of producing multiscience education and understanding the changes occurring in Mozambican culture. This is the manifestation of the 'recuperation' concept proposed by Carter (2004). My intention in multiscience teaching is to promote indigenous sciences and to foster the dialogue among those sciences without privileging any of them or using them simply to support the teaching of World Modern Science. One of the challenges is to distinguish the knowledge among our various ethnic groups - Machangana knowledge, Macua knowledge, Chopi knowledge (just to name a few) – and from World Modern Science.

My previous chapters and my understanding of postcolonial theory shown above have addressed this issue. I see World Modern Science as one of the local sciences practised in Mozambique. It was not invented in Mozambique, but it is a product of human beings and so also belongs to Mozambicans. The same is applied to other knowledges: all knowledge originated in specific ethnic groups belongs to all of us. I know how hard it is to accept this idea. It is much easier to accept that Mozambican activities affect the global environment than what was apparently invented in the West belongs also to Mozambicans.

'Why did I end up justifying that both knowledges are mine while resolving how to distinguish them?' readers may wonder. Probably this stance of being an owner of the knowledge is necessary to avoid the alienation from my culture that is (was) attached to my learning of World Modern Science.

I do believe that even if both knowledges are mine I still need to distinguish each of them. World Modern Science and indigenous knowledges use different logics and represent different ways of reasoning. For example, according to World

Modern Science in each of the following examples there is a unique and quantifiable cause: a) a car moving – the force acting on the car; b) a student succeeding in school – the amount of time that s/he has dedicated to studies; c) an athlete succeeding in a marathon – s/he is the best of other competitors; indeed to testify this reasoning s/he will receive a medal. The examples that I have given show that for World Modern Science for each event there is a single cause. This is emphasized by the fact that when this 'cause' is grasped it is also cultivated when the success is pursued. In other words, the knower in World Modern Science will do whatever is necessary to have a force acting on his car, will spend as much time as s/he can in order to succeed at school, and will be stoically repeating alone the marathon to be always better than other competitors: I call this 'the cultivation of the cause of success'.

In turn, in indigenous knowledge each event has multiple causes each of them being determinant; consequently, the knower using indigenous knowledge should consider in each event all known and unknown variables. I see this way of reasoning as environmentalist or ecological (Afonso, 2007) in which for the system everything should be in place. In order to facilitate the comparison between the two ways of reasoning let us consider the examples above: a) a car moving – the last service done is still valid, I have checked the oil in the engine, the force is acting on the car, I have protection against the bad spirits, I am at peace with my family, relatives and ancestors; b) a student succeeding in school – s/he was able to have enough food and to not sleep while the teacher was explaining, s/he lived close to school and did not have to walk a long distance, s/he was dedicated to studies, her/his ancestors protected her/him against the strong temptation of being deviated from studies and s/he was at peace of mind with her/himself, family, relatives and ancestors. The same reasoning is applied for an athlete winning a race.

I argue in this chapter for the inclusion of forms of reasoning other than World Modern Science into the science classroom in Mozambique. Bringing in other forms of reasoning will legitimate their existence and use and help to eliminate the problem of alienating students and ourselves from our culture. In this way the different knowledges that exist in the world will not be

distinguishable according to whom they belong but according to how they can be used.

Figure 5.7. Timbila

Figure 5.8. Conga-drums.

Figure 5.9. Drum kit.

Which instrument is traditional or modern? Is this question more important or is knowing how to use that knowledge according to the context more important?

As a science teacher, have I helped students to enter into the culture of science or into the culture of the West? The culture of science education in Mozambique is imposed by the science curriculum under a universalist view of World Modern Science in which science is not human, does not incorporate emotions and covers all phenomena in the entire world by its laws and principles. Furthermore, being not human means to be non Mozambican and belong to the West. I am struggling to emancipate myself from this view and embrace the view I am developing in this thesis in which the development of World Modern Science incorporates people from different backgrounds and creates its own culture and that to be a scientist is not restricted to any specific ethnic group (Cobern & Loving, 2001; Nikulov, 1999).

Teaching in a Multiscience Perspective

According to my experience we have been teaching World Modern Science from a multicultural perspective that whatever exists in a specific culture can help to establish the way of thinking of World Modern Science. The weakness of this procedure is to promote

This teaching refers to the postcolonial period in Mozambique. Before independence there was an attempt to eliminate the local-indigenous culture.

World Modern Science not as a result of women and men working from all over the world but as belonging exclusively to the West. However, many of the concepts included in World Modern Science were developed in non-Western societies (Semali & Kincheloe, 1999; Verma, 2004). This procedure of promoting World Modern Science as the only legitimate science culture that exists on the Earth ignores or rejects ideas that cannot be incorporated by World Modern Science. Furthermore, because all attention is directed to teaching World Modern Science, there is no investment in developing strategies for teaching indigenous culture.

If World Modern Science was taught in a multiscience perspective, the concern would be to promote World Modern Science and indigenous knowledge. By doing so, multiscience perspectives would help students to discover why their culture is important. The main challenge in this perspective of teaching, in Mozambique, is that teachers, students and schools are embedded in a multicultural society that has been instigated by the colonial power to cultivate prejudices among its ethnic groups. Hence, each of the participants in the education process needs to acknowledge those biases and move towards a critical perspective (Gomez, 1991).

The critical perspective will allow each Mozambican to accept other identities, analyse inequities that exist in each ethnic group and among ethnic groups, and aim not to construct a fixed identity but to have an evolving identity that can assume all the characteristics of the various ethnics groups that exist in Mozambique. In the science classroom guided by a multicultural perspective, we need:

> not only to teach children about other groups or countries. It is also to help children become accustomed to the idea that there are many lifestyles, languages, cultures, and points of view. The purpose of multicultural curriculum is to attach positive feelings to multicultural experiences so that each child will feel included and valued, and will feel friendly and respectful toward people from other ethnic and cultural groups. (Gomez, 1991, p. 4)

Therefore the multiscience perspective rejects the idea of viewing World Modern Science as above culture. In my Masters Degree I argued that one way of helping students to acquire a multicultural perspective and consequently cross borders between cultures in and outside of Mozambique is Locally Available Materials Technique. I was also envisioning that Locally Available Materials Technique could allow students to participate in the wealth of society. This stance reflects the teaching-learning process through the perspectives of students.

> As we change our participation, we learn. But as we change our participation, the world we experience also changes. Learning is therefore constituted by changing participation in a changing world. This therefore also changes how we might look at teaching. Teaching no longer is the transfer of information but has to be conceptualised in terms of opportunities we can set up that afford students possibilities to change their participation in a changing world. (Bhabha, 1994, p. 44)

In this way, Locally Available Materials Technique can connect science, technology and society, which is a trend (Bennett, Lubben, & Hogarth, 2006) that I support. However, this thesis is not situated within the STS movement.

Connecting Science, Technology and Society (STS)

The teaching that connects science, technology and society (STS) tries to make science more accessible, useful and enjoyable for all students. This teaching is often called *context-based* or *STS* approaches. Context-based approaches are understood as those which have their starting point of teaching science based on the context and application of science. In the traditional teaching of World Modern Science, the application comes after students show an acceptable theoretical level of understanding. Thus context-based approaches are student centred because they are guided by students' contexts. STS approaches are understood as those which connect science, technology and society (Aikenhead, 1994; Bennett et al., 2006). STS curriculum can be characterised by one or a combination of the following aspects:

> A technological artefact, process, or expertise, the interactions between technology and society, a societal issue related to science or technology, societal science content that sheds light on a societal issue related to science and technology, a philosophical, historical, or social issue within the scientific or technological community. (Aikenhead, 1994, p. 5)

The differences between traditional and STS approaches of teaching science is well described in Table 5.1.

Table 5.1. Differences between World Modern Science teaching and STS

World Modern Science	STS
Survey of major concepts found in standard textbooks	Identification of problems with local interest/impact
Use of laboratories and activities suggested in textbook and accompanying lab manual	Use of local resources (human and material) to locate information that can be used in problem resolution
Passive involvement of students assimilating information provided by teacher and textbook	Active involvement of students in seeking useful information
Learning being contained in the classroom for a series of periods over the school year	Teaching going beyond a given series of class sessions, a given meeting room, or a given educational structure
A focus on information proclaimed important for students to master	A focus on personal impact, often starting with student curiosity and concerns
A view that content is the information included and explained in textbooks and teacher lectures	A view that content is not something that merely exists for students mastery because it is recorded in print
Practice of basic process skills, but little attention to them in terms of evaluation	Process skills played down
No attention to career awareness other than an occasional reference to scientists and their discoveries (most of these long after their lifetimes)	A focus on career awareness, especially careers that relate to Science and Technology and not merely those related to scientific research, medicine, and engineering
Students concentrating on problems provided by teachers and textbooks	Students performing in citizenship roles as they have been identified
Learning occurring only in the classroom as a part of the school's Science department	Study being visible in a given institution and in a specific community
Science being a study of information where teachers control how much students acquire	Science being an experience students are encouraged to have
Learning focusing on current explanations and understandings; little concern for the use of information beyond classroom and performance on texts	Learning with a focus on the future and what it may be like

(Adapted from Yager, 1991)

I accept and support STS approaches. One of my tasks as a teacher educator is to teach World Modern Science and I have found that the STS approach offers many suggestions on how to teach World Modern Science. I understand STS approaches as an improvement of standards or traditional ways of teaching World Modern Science. The merit of the STS approach is to acknowledge the influence of the environment in the teaching learning process.

My problem with the STS approach is that it focuses only on World Modern Science. Probably this can be seen by questions proposed by proponents of the STS approach.

> Does teaching science through the use of everyday contexts help school students understand science any better? Does teaching in context improve school students' attitudes to science? Are there differences in the effects on girls and boys, or on students of different ability? (Bennett et al., 2006, p. 348)

By acknowledging different ways of knowing but not different knowledges STS approaches end up being in support of the universalist view of science (see next section). How do I justify this claim if STS teachers are trying to teach science according to students' needs, interests and situatedness? I could not find in the texts that the promoted 'science' is to be understood as being one science among others. In this way STS probably can be categorized as an example of identifying science theory or technique with problems of practice, without the inclusion of moral concern, as referred to by Greene (1994). Moral concern could emphasize that the scientific solution offered to a problem is based on World Modern Science, which results from the development of Western science, which is only one of the local-indigenous sciences that exist in the world.

The Universalist View of World Modern Science

A universalist view of World Modern Science is based on three assumptions: (a) reality is independent of humans' views about it; (b) reality is always structured in the same way everywhere; and (c) the structure of reality can be, at least, partially grasped. It also claims that many phenomena can be explained, predicted and

controlled without bias: “the character of the natural world is unrelated to human interests, culture, race or sex. Ultimately, the concept is judged by the object, not the other way around” (Stanley & Brickhouse, 2000, p. 37).

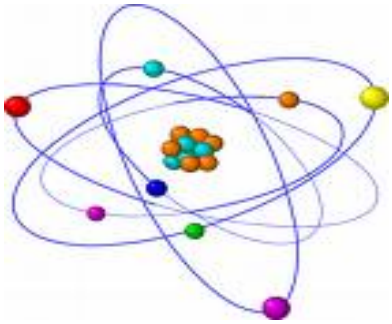


Figure 5.10. Atom.

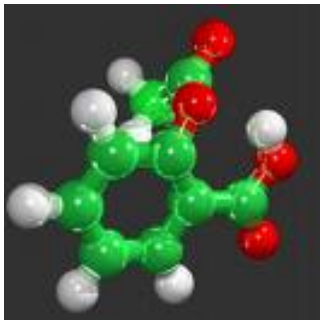


Figure 5.11. Molecule.

Figure 5.12. Discovery

For scientists of the World Modern Science the whole world is formed by atoms and molecules; their duty is to discover how those molecules were joined by nature and how can they join in the way that they wish. ‘Wish’ is a human quality, which ‘wish’ is governing science? Where do the human beings stand in science? Is World Modern Science a reflection of nature or a reflection of the ‘wish’ that governs it?

According to the universalist view, a single cultural approach needs to be addressed in the science classroom, for the most part, in order to show that ideas from other cultures are wrong and that the ideas of World Modern Science are correct. Ironically, this view is justified by moral[3] universalism which espouses ‘respect’ for everyone and for every culture.

> In fact, exposing students from non-Western cultural backgrounds to the superiority of Western scientific methods and knowledge while exposing the epistemological deficiencies of their own culture’s scientific ideas is essential to good science education (Stanley & Brickhouse, 2000, p. 38)

The legitimacy of moral universalism is questionable because ‘bias’ characterises all human activities:

[3] Moral universalism prescribes (Bilton et al., 2002; Stanley & Brickhouse, 2000) a moderate cultural relativism in which all cultures (except excessive ones such as Nazi Germany) should be equally accepted. The ironic aspect is that many cultures, including mine, were not allowed to exist by colonizers using this moral reasoning.

> To begin with, some of our assumptions are so deeply imbedded in our discourse that either we are not conscious of them or, if we are, it would not occur to us that they could be questioned. Furthermore, when we do suspect some of our assumptions, there is no way to question them without assuming many others are valid, even though we cannot confirm those assumptions we must hold as valid in the process. Humans could not even think if they did not assume (or act as if) certain things were true. Thus, as humans, our prejudices are not merely a difficulty we must learn to live with but something without which human life, including science, would not be possible. (Stanley & Brickhouse, 2000, p. 40)

World Modern Science, also called 'modern science', 'standard science', 'conventional science', and 'official science', refers to the World Modern Science method (observation, hypothesis, testing hypothesis and conclusion) and to the organised body of knowledge gained through this method. However, the meaning of science is broader; it can be understood in at least three different ways (Ogawa, 1995). The first view is that science portrays what is believed by scientists from all over the world with differences in nationalities, individual knowledge, local-indigenous knowledge, but they constitute a cultural group that believes in World Modern Science.

The second view is that science is a different way of knowing that is inherent to the Western tradition. According to this perspective, science is comparable to religious, artistic, political or philosophical ways of thinking. The third view of science is as a cultural product. In this view, science is an activity that aims to explain the physical world. Explanations of the world concern all cultures and, within each culture, there is a science that is called 'indigenous science' (Aikenhead, 1997, May May May May; Ogawa, 1995).

The first view, that science portrays that which is believed by scientists, reveals that they share norms, values, beliefs, expectations, and conventions, forming in this way the culture of World Modern Science. The World Modern Science culture has a number of descriptors including mechanistic, materialistic, reductionist, empirical, rational, decontextualised, mathematically idealized, communal, ideological, masculine, elitist, competitive, exploitive, impersonal and violent (Aikenhead, 1997, May May May May). Indeed my acculturation into

World Modern Science made me think that all phenomena occurring on Earth can somehow be categorized and these categories are governed by specific rules that I could discover if I was able to collect the right data and was inspired to see the patterns in the data. Furthermore my conclusions could be applicable everywhere in the world. I learned that this is only valid for scientists of World Modern Science because it is largely accepted that the view and interpretation of phenomena is influenced by language, culture, physical conditions and events (Kawasaki, 2007; Ogawa, 1995).

Science can be further distinguished at two levels; the individual level and the cultural or societal level. These levels could be called 'personal' and 'indigenous' science, respectively, in terms of their representations of reality. These representations are held individually or collectively. The representations are gained through social activity, rather than through reasoning, and they constitute a perception of reality. In *Indigenous science*, the perceptions are collective and culturally-based, while in *Personal science*, individuals construct their own perceptions. Individuals usually switch from Indigenous to Personal science when they are communicating with others (Ogawa, 1995).

World Modern Science is a rational perception of nature that offers naturalistic and material explanations that are objectively and empirically testable. This set of perceptions and explanations is shared and authorised by the scientific community (Cobern & Loving, 2001; Ogawa, 1995). Anyone who wants to understand scientists and what they do, first of all, needs to acquire their rational perception of reality.

Today, scientists, who are from nearly all cultures in the world form a distinct community, with its own culture. This culture is different from Western culture where the population guides its everyday life by its local-indigenous knowledge. This fact indicates that there is a difference between World Modern Science and local-indigenous Western knowledge that identifies the majority of Westerners. According to Aikenhead and Jegede (1999), students in so-called developing countries and in so-called developed countries experience World Modern Science as a foreign culture. As individuals, scientists have their personal

knowledge and local-indigenous knowledge. Consciously or not, they act (or should act) as mediators between World Modern Science and their personal knowledge and local-indigenous knowledge (Ogawa, 1995). This suggests that the teaching of science should be conducted from a multiscience perspective, incorporating local-indigenous knowledge, personal knowledge and World Modern Science.

Teaching science in a multiscience perspective is a question of social justice. There are similarities and differences among African and non-African societies. My aim is to characterise these similarities and differences in a way that I can feel accepted in a community as a human being while, at the same time, preserve my cultural identity. The notions of local-indigenous knowledge and World Modern Science that I was holding before my postgraduate studies created conflict in me. Those notions made me feel, on the one hand, like an local-indigenous person who was different in nature from Westerners while, on the other hand, because of my success at school I started to doubt about the legitimacy of viewing the knowledge that I was learning as a borrowed knowledge and I questioned myself: 'Is this the only science'? Do Black people have science? My age and limited knowledge did not allow me to explore further those questions but today I claim that the teaching of science in Mozambique and elsewhere will be complete only when it incorporates personal knowledge and local-indigenous knowledge.

Indigenous Science

Some of the terms used by Aikenhead (1997, May May May May) to describe local-indigenous knowledge are thematic, survival-oriented, holistic, empirical, rational, contextualised, specific, communal, ideological, spiritual, inclusive, cooperative, coexistent, personal and peaceful. It is knowledge shared in a specific cultural group and held by enough people that allows comprehension among them. Local-indigenous knowledge, however, is independent of any particular person or group. Local-indigenous knowledge is related to what local-indigenous people know and do, and it shows the experience accumulated by local-indigenous communities. Therefore, all of us worldwide are members of local-indigenous

knowledge, which is sometimes called 'ethnoscience' (McKinley, 2005; Ogawa, 1995; Semali, 1999). This perspective contrasts with the view that indigeneity and local-indigenous knowledge are related to the primitive, the wild and the natural. My standpoint is that all of us in a given location are (un)consciously interacting with a given environment using local-indigenous knowledge that shapes our lives. Local-indigenous knowledge is characterised by cultural beliefs and history. This broad understanding of local-indigenous knowledge leads me to conclude that in Mozambique we have many overlapping local-indigenous knowledge systems the promotion of which is a challenge for our imagination.

Mozambique is formed by many relatively small local-indigenous communities, and because of this the term *indigenous* loses its former discriminatory meaning when used by Mozambicans. This situation differs from the Australian, American, New Zealand and Canadian situations where 'indigenous' refers to a minority group and 'indigenous knowledge' is an extension of the discrimination that people are suffering. One expression of that discrimination is the denial that they belong to a given country. Maybe a better expression could be 'Canadian indigenous knowledge', 'American indigenous Knowledge', and so on. From now on as a way of protesting against the inequalities promoted by the expression *indigenous knowledge*, I will use the term *local*-indigenous *knowledge*.

Another characteristic of Mozambique is that ethnic groups are mixed. The mixture of the population is the result of two factors. Government policy following independence was to mix the population so that tribes could get to know each other and prejudices among tribes could be reduced. In addition, the war caused people to be spread all over the country. One of the results of this mixture is that many married couples are from different ethnic groups. As a consequence, in many of these families, the Bantu languages are not used.

The issue of giving value to local-indigenous knowledge in Mozambique challenges national policies to respect the history of all ethnic groups, the variety of languages that exist within the country (Table 5.2.), national economic development and the ethics imbibed in each local-indigenous culture (McKinley,

2005). My view is that in the field of science education the challenge is not only how to give value to local-indigenous knowledge but how to form a national curriculum with both local-indigenous knowledge and World Modern Science.

Table 5.2. – An indication of language distribution in Mozambique

Language	**province**	**Some dialects**
Barwe, Dema, Nyanja, Nyungwe, Sena	Tete	Balke
Chopi, Tswa, Tsonga, Tonga	Inhamban/ Gaza	Copi, Ndonge, Tonga, Khambani
Chuwabu, Kokola, Kunda, Lolo, Lomwe, Maindo, Manyawa, Marenje, Nyanja, Phimbi, Sena	Zambezia	Nyaringa, Marale, Karungu, Maindo
Koti, Lomwe, Makhuwa, Nathembo	Nampula,	Ekoti, Enatthembo
Makhuwa-Marrevone, Meeto, Moniga, Saka, Shirima, Makonde, Makwe, Makwe, Mwani, ngoni, Swahili	Cabo Delgado	Makhuwana, Naharra, Enlai, Nampamela
Manyika, Sena, Tewe	Manica	Boka, Bunji, Bvumba, Guta, Domba, Here,
Ndau, Sena	Sofala	Shanga, Gova, Danda, Dondo
Ngoni, Nyanja, Swahili, Yao	Niassa	Caia, Bangwe
Ronga , Zulu	Maputo	Konde, Putru,

Adapted from (Gordon, 2005; Kroger, 2005)

Figure 5.13. Mozambican Map.

Ethnoscience is the art or technique of explaining, knowing and understanding in different cultural contexts. Therefore, in order to identify the ethnoscience of a given group it is necessary to identify the knowledge and practices used by cultural groups in their attempts to explain phenomena, to understand the world around those groups; that is, the reality that they perceive and how they deal with that reality (D'Ambrosio, 1990).

Local-indigenous knowledge or ethnoscience is locally hegemonic and is transmitted within the culture through daily activities (Ogawa, 1995). Consequently, the introduction of Mozambican culture (local-indigenous knowledge) should be made by analysing in the science classroom our daily societal activities. I am thinking of activities that include, for example, water,

cooking and health. These analyses can be made using multiscience as a 'counter-hegemony' to World Modern Science.

Figure 5.14. There is no single answer to the questions: What should and should not be taught in the science classroom in Mozambique? Who should decide?

This view of local-indigenous knowledge is new to me. Before, I saw local-indigenous knowledge as that which distinguishes Blacks and Whites in the colonial context of Mozambique, that which distinguishes science and not science, and that which distinguishes industrially developed and non-developed countries. Previously therefore, I argued wrongly that in Mozambique it does not make sense to talk about local-indigenous knowledge because all of us are Black or belong to the same non-industrialised or, for some, non-developed country.

The hegemony of World Modern Science comes from its special treatment. If local-indigenous knowledge can have the same treatment then it can acquire the same importance as World Modern Science knowledge. This is well illustrated by Bilton et. al (2002).

> Scientific knowledge is not powerful because it is true; it only seems to be true because it is powerful. It is politics that establishes certain accounts of reality as influential. Therefore, it is not the proximity to truth that explains the dominance of a system of knowledge in any time or place but the methods its supporters use to promote it. (p. 433)

My assumption is that if Mozambicans could recognise their indigeneity, then the struggle to find a way for the national curriculum to provide 'space' for local-indigenous culture could be much easier. The effort to link what is learnt at school with students' everyday life is currently left to the students.

The descriptions of World Modern Science and local-indigenous knowledge show that both are empirical, rational, communal and ideological. Hence, it is possible to combine them into 'traditional ecological knowledge' (TEK) (Aikenhead, 1997, May May May May). However, this is not happening because scientists of World Modern Science deny the validity of local-indigenous science. One reason for this stand is the belief that 'rationality' can be found only in Western science. Although I can comprehend the colonizers' stand about their knowledge and local-indigenous knowledge I cannot understand why this reason pushed them to the extent that they tried to eliminate local-indigenous knowledge. In Mozambique the colonizers also affirmed that local-indigenous knowledge is (a) closely tied to place and cannot be exported, and (b) is based on spirituality, hence it is a manifestation of superstition and fatalism and the users of that knowledge were not allowed to practice it. For example, local-indigenous languages were prohibited in schools and other public places. I question whether it is not a contradiction to state that there is only one logic and then affirm that you are eliminating the logics that do not lead to **the T**ruth?

Why So-called Indigenous Science Should be Included in The Science Classroom

All cultures should have the same value. This sentiment is in contrast to what is currently happening in Mozambique, where the tendency is to regard World Modern Science as the standard, without analysing the possibilities offered by local-indigenous sciences. Introducing local-indigenous sciences may be a pre-requisite to achieving 'science for all' (Jegede & Aikenhead, 1999). The achievement of science for all implies necessarily different types of learning and achievement in different sciences by different students. The different learning that will occur among students can be understood in terms of 'collateral learning'

theory (Jegede & Aikenhead, 1999). (See my understanding of this theory in the Glossary).

General reforms of education systems are failing because they do not include culture sensitive epistemologies such as social constructivism in order to facilitate the border crossing made by students from and to their culture. These culture sensitive epistemologies will allow Mozambican students to express what they think and feel in science classrooms (Jegede & Aikenhead, 1999) and, consequently, their views about their own personal and community development. This is a way to understand the nature of learning and what it means to teach science.

The African science classroom is the location of many sub-cultures in which students live (Jegede & Aikenhead, 1999). From a cultural anthropology view, to learn science is to acquire the culture of science. However, the culture of World Modern Science should not be transmitted with a superior status in relation to other sub-cultures, because this procedure can threaten the local-indigenous culture. The effect, based on the superiority in which World Modern Science is presented, can be seen as poor performance at school and non-application of scientific concepts outside of school. Different effects can be achieved if acculturation respects students' lives.

From a multicultural perspective in which the Mozambican science classroom is seen as one of the sub-cultures in which Mozambican students live, many students need support to cross the border between their own culture and World Modern Science culture. Failure to cross the border successfully can be seen as Mozambican students' negative reaction to a 'strange culture'. The introduction of local-indigenous culture in Mozambique, then, may help students and teachers to recognise themselves (see Chapter Four), and it may alleviate students' pain of living in two separate worlds, a pain felt also by many teachers.

> Very often teachers speak a home language different from the national language when they are not at school; follow traditions and customs that are not shared by the national culture; participate regularly in rituals and beliefs that are not similar to what they teach or read in school textbooks; and rationalize and make plans for their future and

> the future of their children based on epistemology sometimes antithetical or in direct opposition to Western or European epistemologies prevalent in current school books read daily by African students. (Semali, 1999, p. 311)

The multiscience classroom would be a place for expanding Mozambican students' and teachers' views, as their locating culture will be one of the cultures included in the teaching/learning process. The acquisition of new knowledge would be smooth, as it would be achieved with the intention of improving students' established views and not replacing them.

Furthermore, the introduction of local-indigenous culture may be an essential condition for many Mozambican students' success in school. Mozambican students who, for centuries, have been excluded from the process of generating knowledge and getting benefits from World Modern Science, mathematics and technology, might become more involved in the process of decision-making about what to learn, how to learn, and why to learn, based on their own culture. This would constitute a shift from teaching/learning World Modern Science for understanding to the promotion of science agency (Empson, 2002). Science agency can be seen as eagerness to acquire scientific knowledge and empowerment given by learning and using science. Signs of science agency can be self-awareness of learners and looking for better conditions of living for themselves and their community.

From the standpoint of science agency, the concern of teaching is to develop not only scientific concepts but the individual as well. A focus on individuals would enable students to discover themselves and what they want to be by stimulating them to address the question: "Who am I? Who will I be? How hard should I work and toward what end? How am I doing and how can I tell? Can I make a difference in the world? Do I have any control over my own life?" (Noddings, 1993, p. 153).

In this way the introduction of local-indigenous knowledge will aim to complement World Modern Science through eliciting local-indigenous explanations of the physical world. My conclusion is that effective teaching of

World Modern Science requires the inclusion of local-indigenous knowledge, first and foremost, in order to create conditions for cultural border crossing and, second, so that students will better understand themselves and their colleagues.

The introduction of local-indigenous knowledge in Mozambique will follow the attempt made in Tanzania under the influence of Nyerere. Tanzania adopted a curriculum called *Education for Self-Reliance* which was designed to give a Tanzanian face to the curriculum. Similar initiatives have taken place in Botswana, Kenya, Guinea, Uganda, Zaire, Zambia and Zimbabwe. The poor outcomes of these initiatives are due to: lack of clarity of what should be achieved by inclusion of a local-indigenous curriculum: lack of funds to implement the curriculum; lack of macro planning, which did not consider local-indigenous conditions; lack of a research culture; the alienation of many participants from their own culture; lack of sympathy in relation to colonial and historical heritage; lack of community participation; and lack of communication between postcolonial theorists and development theorists (Briggs & Sharp, 2004; Semali, 1999).

Figure 5.15. The lack of healthy connection with nature is a threat to the integration and development of local-indigenous knowledge.

Three additional elements have contributed to the 'failure' to bring development through the introduction of local-indigenous knowledge into the curriculum. First, the promotion of local-indigenous knowledge can be seen as a threat to World Modern Science scientists and those who have their 'empires' based on World

Modern Science. Although they may outwardly promote local-indigenous knowledge, they may not necessarily contribute to its implementation. Second, only a very small part of local-indigenous knowledge is allowed to be part of the curriculum. That knowledge is often related to cultivation (soil management and water preservation) and medicinal plants. Usually this knowledge is acceptable as it does not constitute a direct alternative to the World Modern Science point of view. This knowledge can also be taught using the same curriculum methods designed to teach World Modern Science (Briggs & Sharp, 2004).

The reasons outlined above for poor outcomes in introducing local-indigenous knowledge may not be faced in Mozambique if my proposal of understanding local-indigenous knowledge as knowledge is accepted. Mozambican culture incorporates obviously local-indigenous knowledge which in some literature is called *indigenous* knowledge. My understanding of *indigenous* knowledge aligns with a multiculturalist perspective which views all knowledges, including Modern Science, as existing within a cultural context. My view is that to consider Western science as being global implies that local-indigenous knowledge has an inferior status (Aikenhead & Jegede, 1999; McKinley, 2005).

It seems to me that in Mozambique it does not make sense to talk about local-indigenous knowledge, for two reasons. First, everyone is native from a given place, and consequently local-indigenous from the same place. Therefore, Western knowledge is just a different form of 'local-indigenous' knowledge. The hegemony of Western knowledge comes from its special treatment. If 'local' knowledge can have the same treatment it can acquire the same importance as Modern Science.

Second, most Mozambicans are local-indigenous; our struggle is to find a way for the national curriculum to provide space for local-indigenous culture. The effort to link what is learnt at school with students' everyday life is currently left to students, and Mozambican ways of knowing are not recognized in schools. We are still struggling for the inclusion of our local-indigenous culture for two reasons. After independence our national curriculum was based on the curriculum developed by Portuguese colonialism and, as individuals, we are still strongly

influenced by the hegemony of colonialist culture. For example, many teachers, although members of local-indigenous communities, because of the way they were raised and educated in school cannot promote local-indigenous ways of knowing (Semali, 1999).

Mozambique is formed by many relatively small communities. This situation differs from the Australian, American, New Zealand and Canadian situations where 'indigenous' refers to a minority group and 'indigenous knowledge' is an extension of the discrimination that people are suffering. One expression of this is the denial that they belong to a given country. Maybe a better expression could be 'Canadian Indigenous knowledge', 'American Indigenous Knowledge', and so on.

Another characteristic of Mozambique is that the tribes are very mixed. The mixture of the population is the result of two factors. The policy followed after independence was to mix the population, so each tribe could know each other and prejudices among tribes could be reduced. The war spread people and soldiers all over the country. One of the results of this mixture is that many couples are formed by people from different tribes. And in many of these families, the Bantu language is not used.

According to McKinley (2005) the issue of giving value to local-indigenous knowledge in Mozambique challenges national policies to respect the history of all tribes, the variety of languages that exist within the country, national economic development and ethics imbibed in each local-indigenous culture. In the field of science education, my view is that the challenge is not how to teach or develop local-indigenous knowledge but how to integrate this local-indigenous knowledge into the national curriculum so it becomes widespread.

However, the introduction of Mozambican culture will not per se change the fact that the actual education system is a vehicle of Western culture. My objective in introducing Mozambican culture is to show students that Western science is just one way to explain the world. I will do this as a means of promoting multiscience education that challenges the essentialist view of education.

Perspectives of Multiscience Education in Mozambique

While it is clear that the acquisition of World Modern Science requires 'border crossing' (Aikenhead, 1997, May May May May; Giroux, 1993), instead of promoting science as a product to be proud of, the imposition of World Modern Science is a representation of cultural imperialism. In many cases, the vehicle for imposition is the 'subculture of school science'. In general, unconsciously or not, school science promotes World Modern Science as the dominant culture.

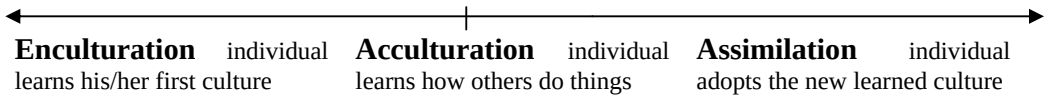
> As we move between micro-cultures, we often negotiate these border crossings so smoothly that we do not recognise that a cultural border potentially exists between the two micro-cultures, for instance, between home and work. Borders may seem invisible or non-existent. It is when we begin to feel a degree of discomfort with another micro-culture that border crossings become less smooth, and need to be managed. Contributing to our discomfort may be some sense of disquiet with cultural differences or our unwillingness to engage in risk-taking social behaviour (depending on the situation, of course). (Aikenhead & Jegede, 1999, p. 4)

My view of multiscience education is that it allows the learners to see the world through others' cultures, thereby promoting the spirit of acceptance of others' cultures.

Two-way border crossing can be achieved through multiscience education (Giroux, 1993; Ogawa, 1995). In Mozambique, the science classroom is a multicultural place. This is a potential advantage that can make a science classroom an ideal situation for the participants to learn about their personal and local-indigenous science, World Modern Science, and the personal and local-indigenous science of their colleagues. Even in the exceptions where students and teachers belong to the same cultural group, students can still learn and exchange their own personal science and World Modern Science. The condition for this to happen is that school programs should allow teachers to include personal and local-indigenous science in the classroom (Ogawa, 1995).

The teaching/learning of science can be seen as acculturation, enculturation and/or assimilation. Enculturation is the process of learning one's

culture. In Chapter One I have argued that the World Modern Science that we are learning, teaching and working for belong to all of us. In the science classroom where my proposal is accepted and the ownership of science is attributed also to the students then the teaching of science can be seen as enculturation. I was enculturated in Machangana culture. Acculturation occurs when the knower discovers other cultures in this process, is still mainly using his original culture but is also learning procedures and techniques that do not belong to his culture (Taylor & Cobern, 1998). Assimilation occurs when the knower crosses the border between the two cultures (Aikenhead, 1997, May May May May; Giroux, 1993) and assumes the second culture (Wallis, Paich, & Borshchev, 2004). The three processes can be illustrated as follows.



Acculturation occurs when the teaching/learning process supports students' views of the world. I see acculturation as a supporting process influenced by the history of colonialism in Mozambique where we were not allowed to use our habits and traditions. If the teaching of World Modern Science can made as an alternative way of living that do not aim to eradicate others ways such as local costumes and traditions; for me, this attitude means acceptance and support to those local costumes and traditions. This support, in general, in Mozambique, in our thirty years of postcolonial history is not there, likely because of the universalist view of World Modern Science.

For Westerners and non-Westerners the process of learning science is largely assimilation. Assimilation occurs when the subculture of science is a foreign culture for students (Aikenhead, 1997, May May May May; Ogawa, 1995).

Westerners and non-Westerners face the same difficulties in the science classroom; their views of the world are not necessarily the same as the ones fostered by World Modern Science.

When assimilation is obligatory, such as that which occurs in a colonial situation, it becomes a disruptive process. Students are forced to abandon or marginalise their culture and replace it by a World Modern Science way of knowing (Aikenhead, 1997, May May May May). In many cases assimilation is a struggle described by concepts such as 'border crossing' and 'collateral learning' (Aikenhead & Jegede, 1999).

In a multiscience setting, enculturation into local-indigenous ontologies and epistemologies, acculturation (learning habits and costumes from others ethnic groups including World Modern Science) and assimilation – experimenting other ways of living and deciding between maintaining or changing ones way of living occur at the same time. In the global village it is not possible to choose among enculturation, acculturation and assimilation. At present in Mozambique, however, we are teaching neither to preserve the local-indigenous culture nor to create scientists. Instead our education system should nurture the appearance of scientists as well as make students proud of their own culture. This is the goal of multiscience in the science classroom.

I see three advantages to adopting multiscience teaching. The first is that multiscience teaching can change the focus of teachers' and students' activities. The decision of where to concentrate should be taken by teachers, students and curriculum designers, answering questions of "When? Where? Why? How? and To what extent?" The second advantage is that local and individual interests can be served. The third advantage is that multiscience teaching can contribute to global understanding. However, the change per se will not necessarily solve our problems. The change is just one factor, and a second factor is the commitment of all participants to achieve the desired objectives.

Multiscience comprises both the teaching of science and teaching about science, the latter being called 'Metascience'. In the teaching of World Modern Science and local-indigenous knowledge in multiscience education the content and limitations of both sciences will be included within a metadiscourse about the nature of science. Multiscience is, perhaps, one of the conditions for achieving education for global understanding.

Education for global understanding

Figure 5.16. Characterising the education system in Mozambique and my vision.

Multiscience for global understanding can be driven by Dewey's philosophy (Saito, 2003). Dewey's philosophy is invaluable in the Mozambican context where for more than 500 years we were impelled to hate each other, as individuals and as members of ethnic groups, and to hate our condition of being Black (Fanon, 1967). Dewey's philosophy incorporates four items: mutual learning through difference, mutual learning based on friendship, a pluralistic vision of the global community and democracy as a personal way of life.

Like Dewey, I am advocating "a middle way of living between no common ground [the relativist stance] and the absolute common ground [the position of total assimilation]" (Saito, 2003, p. 3). My view has evolved to the point that I believe everyone, everywhere, as an individual or member of society, needs to improve his/her social conditions. Hence, interactions inside or outside of societies are opportunities for people to compare and improve or build better ways of living. In this way the goal of teachers' classroom roles is to transmit their experience and to elicit pupils' experience so that each student can learn from colleagues and thus be informed about cultural diversity. By doing so in

Mozambique, I believe we will be preparing students to be world citizens in the sense that they will be given opportunities to know something more than their own culture.

Culture and Mozambican National Identity

I am proud of being Mozambican, but when I am asked what distinguishes a Mozambican from other nationalities the answer does not come easily. However, I believe that there are characteristics which distinguish Mozambique and its people from the rest of the world. Can culture be one of these characteristics? As an educator of science teachers, my activity is shaped, I think, by Mozambican culture. What is Mozambican culture? The answer to this question implies knowing firstly what culture is.

The culture (Hornby, 2000) of society comprises the ideas, customs and art of that society, that is, culture includes knowledge, belief, art, morals, law, customs and any other competence and behaviour acquired by members of that society. My problem with this concept is its essentialist aspect (see Chapter Four). According to the definition, it is possible to characterise definitively the ideas, customs and art of a given society.

The essentialist perspective of this view of culture affirms that people from France, Germany, Spain and Mozambique, for example, should each have something special and unique but this is not limited to their specific knowledge, beliefs, art, morals, laws, customs, capabilities or habits. This is hardly acceptable for me because Mozambicans in general are not characterized by a single ethnic group. Even those who did not cross among ethnic groups for marriage are not characterized by a single ethnic group. In this era of constructing our national identity and globalization, the borders among societies are not rigid, consequently I need a 'better' definition of culture.

I feel like I am contradicting myself but, my point is that even if you have knowledge, skills, or beliefs that others do not have, this does not definitively characterize you. Am I (re)writing this influenced by my recent reading of non/dualism and non/essentialism (see Chapter Three) or by my experience of having been segregated?

Referring to Chapter Four, the definition of Mozambican culture should distinguish Mozambicans (the essentialist aspect) whilst also acknowledging that Mozambicans are human beings among others (the non/essentialist aspect). The main advantage of this definition is that it will recognize the similarities and differences both among societies and within a society. Therefore, culture can be analysed at a societal or individual level. I do not easily see what distinguishes Mozambican society from others, probably because the characterisation of our own culture is a difficult process as it requires detachment from it.

The analysis of culture can be more difficult than the characterization process as it involves questioning what we have been taking for granted. These difficulties explain how hard it is to recognise aspects of our culture that create difficulties in our lives. The difficulty is made worse by the fact that elements of culture are manipulated to sustain the social group in power. This social group promulgates particular sets of values and beliefs and promotes them in several ways.

One notion of culture is a means used by members of a given society to understand each other. In this way, culture can be seen as 'software' (Erickson, 2004) that allows individuals to act and make sense of what is happening around them. The software in which individuals are embedded includes knowledge, beliefs, art, morals, laws, customs and habits, which they learn in their daily life. There are seven ways of understanding the concept of 'culture', divided into traditional and contemporary definitions (Erickson, 2004).

Traditional definitions of culture

Culture as Cultivation – In this notion, developed in the 18th century, culture is acquired through cultivation. Cultivation means to enhance our skills and abilities through effort and discipline. Some of the results of this hard work are the paintings, music, dance, books and records in sport. The effort and discipline required to be culturally cultivated reduces the view of culture to the behaviour of a few people; that is, culture's elite representatives. This is an opposite view from a social science perspective where culture refers to the patterns of sense-making that are part of the organisation of the conduct of everyday life.

In Mozambique, one example of culture as cultivation is traditional dance. Traditional dances such as Makwaela, Xingomana, Tufo and Timbila differ from place to place throughout the country. These dances are usually performed at the airport when the country receives a VIP guest. This can be taken as an indication of the 'pride of country' (the people and the government) in the traditional dances.

Culture as tradition – According to this perspective, introduced in the 19th century, culture is what the society strives to pass on to new generations. Tylor's definition (Harris, 1980) is equivalent to this view of culture. This view of culture in Mozambique is largely used in familiar settings primarily to emphasize what distinguishes different ethnic groups and families.

Contemporary definitions of culture

Culture as Information Bits – This definition refers to the circumstance where each member of a given society does not possess the entire culture of that society but has only part of it, called *information bits*.

Culture as Symbol System – Culture as a symbol system occurs when individuals or groups function through a given set of symbols and see the world through the same symbols; for example, academics, workers, or politicians.

Culture as Motive and Emotion – Repetition of activity improves ability and creates an emotional attachment. Perhaps this view of culture is what explains why Mozambicans are so strongly attached to Mozambique. They have been there for a very long time. They have become attached to the land, its environment and the way of life.

Culture as Distributed along Lines of Power in Society – This view of culture emphasizes that individuals interpret and make their own decisions based on (a) the allocation of power in society, (b) social conflict, and (c) what people want to achieve.

Culture as Residing in Local-indigenous Communities of Practice –

Figure 5.17. A family is one of local-indigenous community of practice.

Community of practice can be understood as a group of people linked together regularly. A country may be a large community of practice, formed by the linking of small communities. The role of individuals within the community of practice changes with their skills. One of the sources of practice is determined by lines of power in the society. In other words, some practices may derive from the social-class, racial, ethnic, linguistic and gender backgrounds of persons and groups in society. The practice demanded by these sources varies from place to place; hence, different communities will have different practices. An individual may participate in more than one community of practice, acquiring different skills within each culture.

The definition of culture '*as residing in local-indigenous communities of practice*' explains why a country called Mozambique and Mozambicans exist. The existence of a Mozambican concept of culture is legitimatised by what we have been facing together: floods, droughts, low annual per capita income, inefficiency of our education system, and the search for a better way of life. This and other common activities and feelings make us Mozambicans.

For Mozambique, this view of culture as residing in local-indigenous communities of practice means we are part of a group which is labelled Mozambican and which is readily distinguishable from other groups. At the same time, the concept allows any one to join or to leave the community of practice.

The definition of Mozambican culture as residing in local-indigenous communities of practice encompasses other definitions or understandings of culture outlined above as well. For example, the community of practice will create/maintain its norms of acting and socialising that can be improved according to community understanding – this is the understanding of culture as cultivation. For those who are entering that community, the cultivation of activities, norms and routines represents the creation of tradition that others have perhaps been following for some time – this is the understanding of culture as tradition. The members of the community of practice may not interpret their reality in the same way using the same background, hence portraying the view of 'culture as information bits' in which each member is not viewed as possessing the entire culture of the community. Culture as a symbol system, as motive and emotion and as distributed along lines of power are also included in the culture as community of practice because of the meaning extracted from the symbols used by the members of the community, their motivation of being part of the community and the power involved in their relationship, respectively. This effort of showing how integrated my view of culture is, has left me with the feeling that there is no best view (understanding) of culture but instead involves different definitions to emphasize different aspects of the same culture.

Thinking why I have opted in the first place for culture as residing in community of practice I realise that I did so motivated by the wish of promoting my culture to the main stream, the stream that is considered in the science classroom. Are not all of us (colonized, colonisers and those who had never participated in colonial movement) residing in local-indigenous communities of practice? However, my level of understanding of my definition of culture indicates that it is possible to show how the definitions of culture by Erickson (2004) are integrated.

National cultural identity

The 'divide and conquer' methods used by the colonial Portuguese power constitute one of the reasons for Mozambicans knowing little about their own ethnic group and nearly nothing about the ethnic groups to which they do not

belong; hence, the widespread lack of consciousness about our national cultural identity.

> *I have once again fallen down the same trap. I was looking at who I am outside of me, and hence I found colonizers as responsible for my ignorance about my identity. Colonizers had influenced my identity but now I know that 'I am the One who I am'! (see Chapter Three)*

Creating a consciousness about our national identity is a complex and passionate issue for me. One dimension of the complexity comes from the way in which the political borders were imposed on the country. Borders connected people who before were separated and separated people who previously were together. This demarcation of our country was imposed by a colonial power. The Berlin Conference (1884-1885) did not respect cultural borders among people. The borders among countries, at least in the African context, likely corresponded to the location of natural resources. However, the problems created by those artificial borders in Mozambique cannot be blamed only on the colonial power as everywhere we have artificial borders (Touval, 1966). The different ethnic groups existent in Mozambique should continue to develop their harmonious way of living together.

One of the difficulties arising from the colonial era is that Mozambicans were prohibited from developing their African identity, as tribes and as a nation. Hence, it is not easy to elicit which African or non-African education, beliefs, myths and interactions determine who I am, and who 'we' are. The challenge for Mozambicans is to develop a tribal cultural identity, a national cultural identity, and a world cultural identity, all at the same time. My question as a science teacher educator is to what extent 'science teaching' can help in the formation of these different levels of Mozambican identity?

The formation of identity is related to what, how, why and whom we are teaching in the science classroom. My experience of learning and teaching World Modern Science combined with this multi layered understanding of our national cultural identity is that we cannot centrally prescribe the way of teaching science for every single school in Mozambique. Even in schools situated in the same area we cannot prescribe because we do not know about the heterogeneity of people

living there. However, the government should set up the criteria for what is needed for students to be considered to have completed a certain grade or course.

Summary of The Chapter

I have discussed in this chapter, based on postcolonial theory, that science education should include local-indigenous knowledge as a way to consolidate our decolonization and to foster the development of our culture and a multicultural understanding within our people and between our people and foreigners. Local-indigenous knowledge varies from region to region and cannot be characterised in a single manner due to its complexity. The introduction of local-indigenous knowledge should not be seen as an alternative to World Modern Science. In this way, they do not compete but complement each other; furthermore, Mozambicans should feel ownership in relation to both systems of knowledge.

The introduction of local-indigenous culture in the education process can serve different purposes. First, including local-indigenous culture in the teaching process can be seen as emancipation for the individual and society, because students are more likely to pay attention to their own 'place' and to eventually improve their standard of living. Second, including local-indigenous culture in the teaching process can foster multiscience education so that Mozambicans become more aware of the multicultural characteristics of their country, expand their horizons beyond the borders of their country, allow border crossing among different ethnic groups and sciences, and better understand World Modern Science. The introduction of local-indigenous culture can work as a counter hegemony to the dominant culture of World Modern Science. Including local-indigenous culture in the teaching process can improve students' science agency (motivation). By incorporating local-indigenous culture into science education, students will not continue to live in two separate worlds, unlike me and many of my fellow students. At school, we used 'strange' concepts to explain the physical world which, if not entirely useless in our everyday lives, did not have much apparent applicability. For this, we had to memorise many concepts and formulas. Local-indigenous culture could make clearer why today's students could learn about the usefulness of science in their everyday lives.

Representation, recuperation and cultural translation are postcolonial concepts that help to identify the aims of including local-indigenous knowledge into the science classroom. In some cases the inclusion of local-indigenous knowledge can perpetuate the hegemony of World Modern Science that we are trying to eliminate. One of these ways is by teaching STS, which connects uncritically science, technology and society.

World Modern Science should be taught from a multicultural perspective so the culture of the place where it is taught can be included in the teaching. At the same time, the local-indigenous knowledge of that place can be taught as an alternative way of thinking and, in this way, complement World Modern Science. This means that we should aim to make local-indigenous people proud of their indigeneity; I am sorry, I meant that we local-indigenous should aim to make ourselves proud of our indigeneity, is this possible?

Indigenous[4] Knowledge

'Indigenous' is a prohibited word in Mozambique
'Indigenous' is a word that evokes (un)touchable things

- the beautiful black colour that I was born with
- my 'identification' given by colonizers
- the discrimination for not having a Western education
- the discrimination to go to prison and slavery
- to hate yourself, the colour of your skin, and your people
- to fight for your belongings including name, land and knowledge
- the knowledge that colonizers never understood

Knowledge is power
Knowledge is given in schools
Knowledge can be understood
Knowledge cannot be touched
Knowledge is a belonging …
Knowledge should remain with the owner

[4] This poem describes also the dilemmas faced by indigenous hence I am not using the expression local-indigenous because the poem protests by itself.

Knowledge is defined by the colonizer
Knowledge helped me to fight the colonizer
Knowledge is defined by me
Knowledge is taught in the colonizer's school
Am I the colonizer?

Indigenous knowledge is a hegemonic force
Indigenous knowledge has just one face in Mozambique
Indigenous knowledge makes you comfortable where you are
Indigenous knowledge makes you become indigenous
Do I want to be indigenous?

This poem allowed me to express my feelings in relation to indigeneity that I could not express using scientific language. In scientific language I would be required to substantiate the meaning of 'prohibited' '(un)touchable' and 'beautiful'. However, without discussing these concepts I have conveyed my understanding of who we (Mozambicans) are and why our knowledge should be included in the Mozambican science classroom. How does this show the relevance of science in our everyday life? (Specific research question 2) That is, why does Mozambican culture in the science classroom constitute a key opportunity to make science teaching relevant to everyday life in Mozambique? Or, in short, what is the usefulness of having Mozambican culture in the science classroom? This is the question that will lead my work in the next chapter (Chapter Six)

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Chapter Six: A Cultural Model for Multiscience Education

Introduction

> … proponents of traditional and modern cultures celebrate cultural difference whilst at the same time recognising the inescapably partial nature of their own self-understandings and self-representations. The actual performance of this discourse, underpinned by critical hermeneutics, gives rise to new hybrid cultures and cultural identities. Neither the modern nor the traditional is privileged; both are transformed. (Taylor, 2006, p. 206)

Figure 6.1. Multiscience education includes different epistemologies and ontologies that can be developed in different ways.

So far in this thesis I have developed a view of education as a cultural process and analysed my identity and justified the inclusion of Mozambican culture in the science classroom. This perspective appeals as it facilitates exploitation of all available knowledges without becoming oppressed by any one cultural influence or otherwise. In other words, science education should consider all knowledge systems as equally viable. I call this exploitation of all available knowledge in the science classroom *multiscience education.* Two critical knowledge systems that are part of multiscience education are local-indigenous knowledge and World Modern Science.

I am pondering how my suggestion of introducing local-indigenous knowledge can succeed if the majority of local-indigenous languages are not written. Is this question reasonable? The apparent absurdity is that the knowledge that I want to teach has reached the 21st century without in general being recorded. Recording our knowledge can widen the teaching process, i.e., teachers will have expanded reference points from which to teach and stimulate investigation into further levels of knowing. However, the fact that not all Mozambican knowledge currently is recorded cannot be an excuse to preclude its introduction into the science classroom.

The inclusion of local-indigenous knowledge will serve, in the first stage, the purpose of recording it in writing. The fact that this knowledge was never documented or taught in schools probably explains its ready replacement by World Modern Science knowledge which has been given privileged value in schools. Local-indigenous knowledge includes local-indigenous imagery, local-indigenous beliefs, local-indigenous stories, local-indigenous history and local-indigenous myths (Semali, 1999).

My main goal in this chapter is to propose a *cultural model of teaching for multiscience education* that incorporates local-indigenous knowledge in science teaching. By doing so I am responding to the research question: How can the teaching of science be made relevant to everyday life in Mozambique? This initial research question was also reinforced by the previous chapter in which I illustrated that local-indigenous knowledge and my identity were hardly part of science teaching in Mozambique. Hence, my cultural model of teaching for multiscience education includes development of students' identity, learning by doing using everyday materials, spirituality, local-indigenous knowledge and local-indigenous language. From now on I will refer to the model throughout this chapter as the Cultural Model of Teaching.

Multiscience Education

Multiscience teaching is required for two-way border crossing. The two-way border crossing can be possible if the referents in our teaching are enculturation and acculturation. I realise now that the goal cannot be just to have the students move back and forward between their local-indigenous culture and World Modern

Science culture but they need also to learn to reflect critically within and about each cultural domain. The Cultural Model of Teaching addresses this need.

> To think and act critically implies always to have in consideration both individual and society. Individuals can act and think critically if they are allowed to have freedom as well as power, but this freedom and power should be linked to the democracy of society. Power that is not linked to democracy characterizes dictatorship. Therefore, we need to reflect critically when we consider ourselves to be teachers and students; when we consider ourselves to be researchers and participants; when we consider ourselves to be government and citizens (Giroux, 1993; Guba & Lincoln, 2005).

The two principles guiding multiscience education, generated in Chapter Five, are (a) there is more than one science and (b) science should help the learner to know and accept his/her own culture and accept other cultures. These principles contribute to the emancipation of students and local-indigenous culture.

Multiscience education can promote the development of individuals as well as communities and country-wide development because teaching is seen to be integrated. By 'integrated' I mean teaching practices that take into account students' lives, the community and the environment. In school, students would not only learn abstract theory but also theory needed for their daily lives. This can contribute towards resolving the issues faced by the planet today that cannot be solved by World Modern Science alone, including famine, alternative sources of energy, AIDS, malaria, terrorism, building our global village and building tolerance among us. I view these problems as an indication of the need for a more critically literate population (Bauer, 1992; Eisenhart, Finkel, & Marion, 1996; Hodson, 1999, 2003; Laugksch, 1999) especially in World Modern Science and local-indigenous science.

The introduction of local-indigenous science is not an attempt to reverse history. In Mozambique, Africans and Westerners have interacted in such a way that both have changed. This interaction has changed not only the people but also the environment (Lye, 1997; Semali & Kincheloe, 1999). Local-indigenous knowledge incorporates a transformative power that can be used "to foster empowerment and justice in a variety of cultural contexts" (Semali & Kincheloe,

1999, p. 15). The restoration of equilibrium should be in parallel to the decolonizing process, analysing how World Modern Science subjugates local-indigenous knowledge.

Multiscience education has the potential to turn students into vectors to develop a democratic society in Mozambique. The characteristics of that democratic society should be decided by everyone in Mozambique, with students as moderators of discussions at home, in the community and throughout the country. For this purpose, the direction for learning for students should not be imposed. First, students should learn to value the knowledge held by their parents and other older relatives and not look on parents and other elders as old-fashioned, a view that often inhibits the assimilation of that knowledge.

The science classroom should help students to assimilate and be critical about the knowledge held by their parents and other elders. I am arguing that for students to become vectors of transformation they need to know what they are transforming on the one hand and, on the other hand, the value of the knowledge held by their parents and other elders. If the Mozambican education system succeeds in turning students into vectors of change this change would in some measure solve the existing problem of young people assimilating parts of traditional and Modern education the use of which is questionable; for example, at home many learn about witchcraft, lies and hate before going to school, but they do not learn how to set a trap for hunting. At school, they learn the laws of World Modern Science which most will never apply in their lives.

For some authors, multiscience education views World Modern Science from a multicultural perspective that involves looking at content, process and context. A particular approach to multicultural science teaching is given by Wei and Tomas (2005) who are concerned with equilibrium between the learning of World Modern Science and its humanistic and social implications:

> The chemistry curriculum in the stage of compulsory education can help pupils understand the roles played by chemistry in society, some issues related with science, technology, society, and their daily lives from the perspective of chemistry. [It can] raise awareness of the need to bring environmental pollution under control and how to make best

> use of chemical resources by using chemistry knowledge and methods. It can also enhance pupils' social responsibility and enable pupils to make more reasonable and scientific decisions when facing the challenges of social issues related with chemistry. (p. 1484)

My problem with this approach is that it does not allow local-indigenous culture to be studied in the science classroom. This, in turn, makes invisible the participation of local-indigenous culture in the curriculum and, most important, in students' cultural development and critical awareness about their world. My proposed Cultural Model of Teaching addresses this situation by considering local-indigenous culture as one of its components. The African way of life that constitutes one of the components of this model stands against the superiority of (a) an individual over his/her community, (b) an individual over other individuals, and (c) communities over other communities. This African philosophy is counter to the assumption of the superiority of Westerners over other people, which has been strategically promoted by (a) linking the origins of World Modern Science to the West, (b) seducing everyone in the world through imperialism and colonialism to accept the superiority of that knowledge, and (c) still preaching that it is Western knowledge even though the knowledge has been assimilated worldwide. The most important feature used in imposing 'Western superiority' is by emphasizing the perceived differences between Western and non-Western knowledge. For example,

> Astrology is not at all scientific for the direct reason that the contemporary scientific community is agreed that it is not at all scientific, not because one can logically show that the practice of astrology (in all its variants) contradicts that simple formula of the scientific method. (Bauer, 1992, p. 4)

I have argued in the previous chapter that this problem can be resolved by teaching science from a multiscience perspective that allows all cultures to contribute in the science classroom with their local-indigenous science. The inclusion of Mozambican culture in the science classroom should be seen as a means to achieve multiscience education and as part of the process of emancipating Mozambican students, first, and our society in general, next.

The multiscience perspective of teaching contributes to a counter hegemony against the dominant ideolology of World Modern Science by enabling students to:

- be more aware of who they are,
- be educated using a broader perspective of science, and
- be able to develop their spirituality.

Another manifestation of the issue of local-indigenous knowledge not being taught in the science classroom is that students are left alone to challenge their feelings and beliefs which may differ from the feelings and beliefs promoted by World Modern Science. This particular form of multicultural teaching promotes the epistemology and ontology underpinning World Modern Science at the expense of local-indigenous epistemologies and ontologies. Besides constituting a hindrance for the majority of students to learn World Modern Science, this would frustrate the efforts made by the Mozambican government to educate its citizens. How can this problem be solved by a Cultural Model of Teaching? How can the Cultural Model of Teaching make science relevant for Mozambicans?

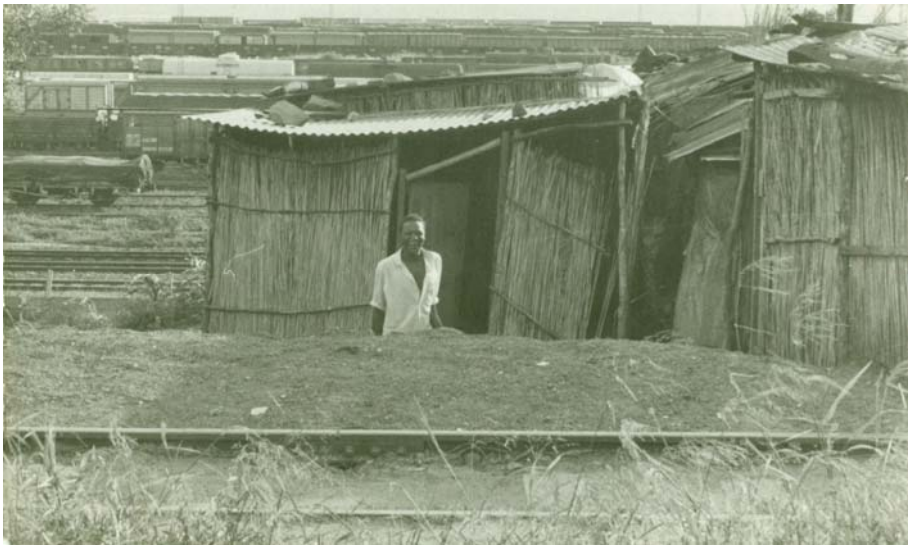


Figure 6.2. Multiscience education should emancipate students.

Cultural Model of Teaching

I have developed this Cultural Model of Teaching from the perspective that the teaching that occurred during the colonial era reflected an essentialist approach (see Chapter Four). This theoretical frame was applied in such a way that it ignored African identity, the interaction among Africans and, ironically, the interaction among Africans and colonizers. Essentialism was, on the one hand, fossilizing Black Mozambicans by portraying them as without culture and born to serve the colonizers. On the other hand, and this is in contradiction with the first stand, imposing on Mozambicans a limited World Modern Science view as a way to enable them to serve the colonizers. This is the science that, in general, is taught in Mozambican schools today.

I have argued through non/essentialist theory (see Chapter Four) that there is no valid reason for imposing only epistemologies and ontologies from World Modern Science in Mozambique. Our ways of life, on the one hand as Europeans and on the other hand as Africans, combined with the high rate of failure at schools, support my claim. Nevertheless, World Modern Science should still be seen as one view of the world that is acceptable. If, however, we want to develop ourselves culturally (individuals and the country) I question: Can we develop ourselves culturally without looking at our own culture? Is it not the lack of cultural context that is making the teaching of World Modern Science frustrating? Non/essentialist and Non/dualist theories are the basis of my Cultural Model of Teaching.

Non/dualist theory (see Chapter Four) helped me to understand that the emergent question <u>about who is the self that teaches</u> is not fully addressed by non/essentialist theory. I understand, using non/dualist theory, that my thoughts, what I do, and what I like and dislike do not constitute me. I am the One who witnesses those events in my life. And that One is composed of these events, my body, the place where I live, my people and my spirit in such a way that cannot be separated into its parts. Hence, I understand that I am analysing my life and profession from a dualistic perspective. Therefore dualist theory allows me to select what to teach, how to teach and to analyse the outcomes of my teaching.

Given these overlaps in perspectives, all of which pertain to my understanding of me, my students and my country, I am proposing that the inclusion of local-indigenous science be made dualistically through stories that can be part of our cultural repertoire, created by teachers and/or students. These stories will have in common that they describe:

- A technique.
- A way of thinking.
- A theory.

In this way, stories that are included in the science classroom will portray an epistemology, ontology and/or axiology related to local-indigenous knowledge and World Modern Science.

My Cultural Model of Teaching is based on multiscience education and employs stories aimed at helping Mozambican students to develop their knowledge and critical reflexivity. Stories about Mozambican life can involve local-indigenous language and everyday materials. However, the inclusion of locally available materials and local-indigenous language is not, per se, a guarantee that students will gain local-indigenous knowledge (see Chapter Three) that could enrich their cultural identities. So far, in Mozambique, locally available materials have only been used in the limited context of learning World Modern Science. This conclusion from my Masters Degree research (Cupane, 2003) suggests that it is important to know when, how and why to use locally available materials.

I recognise the importance of language and locally available materials in multiscience teaching. My aim of using them through the Cultural Model of Teaching is to include in the teaching process local-indigenous epistemologies, ontologies and axiologies. In one word: cultural identity. The teaching of cultural identity expands the traditional teaching of using what exists in my culture to facilitate the teaching of World Modern Science because World Modern Science is just one sub-cultural identity that each of us can assume.

Cultural identity, in Mozambique, is the identity to which learning in the science classroom will contribute. This identity can be manifested by a student assuming 'personal identity', 'the identity of any of our ethnic groups', 'our national identity' or a 'world identity'. Identities are defined over and over by stories. The main advantages of this perspective of identity transmission are twofold: the identification of the individual in non/essentialist terms (see Chapter Four) and the recognition of the individual as a multifaceted definable entity.

Students' cultural identities

The culturally inclusive teaching of science is characterised by acknowledging students' identities and promoting their development through stories. Identity can be understood as characteristics, feelings or beliefs that distinguish each of us (Hornby, 2000). This definition more closely fits my educational aims, including those related to cultural emancipation.

The development of identity, from a cultural perspective, is not addressed in Mozambican schools. For example, in the Physics programme (MINED/DNESG, 2004) the position the student has within the curriculum is not addressed.

A Mozambican multiscience classroom should contribute to the formation of individual identity (see Chapter Four) which shapes and is shaped by the community. The adoption of a Cultural Model of Teaching can help to make students critically aware of the possibilities of their ways of living and to think about what they can explore and envision in a multiscience classroom. These choices will be made based on what they bring from home: local-indigenous knowledge, which includes personal knowledge and the traditions and beliefs of their communities.

Students' identities in the science classroom will be challenged as they move along three main steps in the model (see Table 6.1). In the first step, students will be asked to describe their everyday life and what they know or are imagining about others in a given topic, for example, water issues and ways of cooking. In the second step, they will be asked to identify events and/or their preoccupations in their stories and how those events and/or preoccupations are

addressed with the help of local-indigenous knowledge and World Modern Science. Finally, they will be asked to decide if there is room for changes in what they have described. These steps will show how others can assimilate that culture and how those who are telling their stories have been enculturated into their own culture. The complexity of issues discussed in each step will depend on the level taught.

Table 6.1. Steps in the Cultural Model of Teaching

Step 1	Step 2	Step 3
What are the stories that can describe life in and outside of the local-indigenous community where the school is situated?	What constitutes local-indigenous culture? How do we explain the events in the stories using local-indigenous knowledge and World Modern Science? Does the story portray any preoccupation that could be addressed using local-indigenous knowledge or World Modern Science?	How could we change the stories told?

In the third step of the Cultural Model of Teaching, Jegede's collateral theory of learning could be applied, so that all students might integrate both kinds of knowledge into their everyday life (see Glossary for the concept of 'collateral theory').

One Mozambican way of doing things is that knowledge is gained by listening to and participating in activities with others. This is also called an 'African way of living'.

Figure 6.3. We have been deepening our knowledge through listening and exchanging ideas.

In the African way of living, the education of youth is shared by all adults and takes place whenever the opportunity arises; for example, if an adult witnesses a mistake made by a child in the street s/he is likely to bring it to the attention of that child. Mozambicans are not born with this characteristic nor do they acquire it at school. Bringing students lives into the science classroom will change the way of teaching to be more student centred, thereby helping them to shape their Mozambican cultural identity.

Identities as stories and narrative logic

Scientific literacy is one criterion used to specify identities. Many of us were considered illiterate because we did not know how to write or express ourselves in Portuguese; however, through enculturation into our own culture, we grew to be producers of cultural artefacts. We were and are literate but in different terms to the ones recognised by the colonial power. In my ethnic group, the boys acquire knowledge through oral literacy (Conolly, 2001; Conolly & Sienaert, 2006) and skills when they are involved in producing tools to be used at home or in the hunting activity. Boys and girls learn through oral literacy skills when they are involved in inventing stories, riddles and poems. This process enables all of us to become producers of oral literacy. This is the knowledge and logic that I include in the Cultural Model of Teaching.

Our enculturation (Changana ethnic group) used local-indigenous language as a medium of instruction. I view the usage of local-indigenous language as a way of integrating local-indigenous culture and a way of helping students to have two-way border crossing. The importance of language is that it helps us to articulate our world. In the process of acquiring a language, students become familiar with a given reality, sharing, in that way, the traditional worldview of their community (Kawasaki, 2002; McKinley, 2005). Hence, the use of local-indigenous knowledge and language can help to achieve the aim of helping Mozambicans to become world citizens. For this, we need to start the education process based on where students live, and for this local-indigenous language is appropriate.

Another outcome arising from the use of local-indigenous language is the integration of different local-indigenous languages that exist in Mozambique and the integration of each of these languages with our national language Portuguese. How complex is this process is shown by the number of languages that exist in Mozambique: Swahili, Yao and Makonde, Makua-Lomwe, Nyanja, Nsenga-Sena, Shona, Tsonga (Shangaan, Ronga, Tswa) and Copi (Lopes, 1998), just to mention the ones considered 'major languages'. In this process, both cultures influence each other. Local-indigenous people will acculturate, drawing from other cultures anything that is suitable for them to live better. I call this 'development of local-indigenous culture'. The development of local-indigenous culture can help to end the many isolated worlds that Africans live in: a process called hybridisation by others (Ashcroft, Griffiths, & Tiffin, 2000; Laragy, 2005).

There are many challenges in using local-indigenous language. The first is that the local-indigenous language may not be developed enough to teach all concepts that we want to teach. For me, this is not a problem because my intention is to use the language to the extent that it can help students to understand better what I am teaching, whether that is World Modern Science or local-indigenous knowledge. The concepts which do not exist in the language can be borrowed from other languages, thereby creating what Bhabha (1994) terms a 'third space' and Afonso (2007) terms 'eco-pedagogy'.

Bhabha (1994) and Afonso (2007) suggest a solution for the Mozambican situation in which nearly in every place local-indigenous languages coexist. Accordingly we need to establish an equilibrium among the local-indigenous languages in Mozambican schools. This equilibrium can address the issue of the unbalanced power relationship that can exist among those languages, especially if one of the languages is considered the coloniser language and (un)consciously is privileged.

The second challenge to using African languages in Mozambique is that, in general, the number of fluent speakers of any one local-indigenous language in Mozambique is very small. This can be explained by the policy of assimilation following colonialism in Mozambique that left Mozambicans without any choice

other than to adopt Portuguese as an official language. The difficulties created by this situation are obvious. Overcoming these difficulties will provide opportunities for students to think in a language other than the one used at home.

The usage of different local-indigenous languages will be underpinned by the acceptance of different logics of understanding the world. I can use the concept 'force', which is taught using the logic of World Modern Science, to demonstrate the existence of these different views. Multiscience education should allow multiple understandings of the world; for example, *force,* according to World Modern Science is the cause of change in movement, while in my *personal* science it is what I am applying to enable me to run. Does it mean that I am proposing a new definition of force in World Modern Science? Of course not! I am arguing that the context in which my alternative definition of force works should be included in the science classroom.

Multiscience education will accept but differentiate both views of *force*. In Mozambique and other ex-colonial countries it has not been easy to avoid promoting the hegemony of World Modern Science because, although we negate it, at the same time we accept the hegemony through the curriculum (Taylor, 2006).

My Cultural Model of Teaching includes stories that can shape each of our identities in different ways. Identity as stories may help to explain the failure and success of students in Mozambican schools where the situation currently is similar to that described by Wei and Thomas (2005) in Chinese junior schools:

- Students' interest of learning is very low.

- Students can not use the acquired knowledge to solve practical problems.

- Students have no sense of responsibility for their country and community.

Identity as stories may help to solve these problems, because students will be asked to tell their stories of success and failure in the learning of science. These stories will portray students' interests, strengths and weaknesses related to science. These stories, which will include students' behaviour, might also give clear

indications to teachers of how the process of studying should be guided. This can be a major way to build identities at school.

> As stories, identities are human-made and not God-given, they have authors and recipients, they are collectively shaped even if individually told, and they can change according to the authors' and recipients' perceptions and needs. As discursive constructs, they are also reasonably accessible and investigable (Sfard & Prusak, 2005, p. 17)

I can relate strongly to the development of identity using stories because stories are a central part of Mozambican culture. I remember my experience of listening to and telling stories and riddles when I was a child. Each story was followed by interpretations.

Figure 6.4. Many events can be used in stories.

I used to hear stories and riddles in Gaza where my family used to go during school holidays. My grandparents were living there at that time in a place called *Ndavene*. It did not have electricity or running water, and the houses were *huts* constructed of local-indigenous materials. Ndavene had a very different environment to the one that we had in Lourenco Marques (Maputo); for example, there were no cars as there were in Maputo. In Maputo, we lived in one of the suburbs. We did have electricity but we did not have running water. It was an overcrowded suburb, like many of the suburbs in Africa.

The stories were told by anyone who felt like it. This often occurred when we were sitting together, waiting for supper in one of the huts used to cook in and store food. Sometimes, when one of the elders present wanted to educate us, s/he would say: *Now it is my turn to tell a story*.

In general, every night was dedicated to stories or riddles, and occasionally we could have both. The riddles were always in the form of a competition in which there were two participating teams. If Team A proposed a riddle, Team B would try to answer. Team A would only stop with the riddles if Team B was unable to

answer one. Next, Team B were obliged by the rules of the game to pose riddles that could not be answered by Team A. The rule was that each riddle had to be logical. The adults were the referees.

I realise today that part of my enculturation into Changana culture occurred while participating in these stories and riddles. Stories and riddles, especially dilemma-stories (Koios, 2007; Settelmaier, 2007) are useful as a means of both socializing and teaching and learning local-indigenous values. Furthermore, they can help to build quick, critical reasoning skills. “In traditional Haya society, riddles, folktales, myths, and historical legends constituted part of the education [informal and formal] imparted to children and youths” (Ishengoma, 2005, p. 142). Therefore, I think stories can be used as a strategy to teach local-indigenous culture and World Modern Science in Mozambican schools.

Figure 6.5. The riddles could be connected with what we were doing during that day or other activities.

The Cultural Model of Teaching contributes to multiscience education because it includes concepts from World Modern Science without worshiping the work of scientists and the technology that accompanies them. The model allows students to think about their own practices and explain those practices using a narrative logic. In this way, the model transforms students into researchers and participants in their research as they are guided to portray events and happenings around them in story(ies) (Barone, 2007; Polkinghorne, 1995). This aspect of the Cultural Model of Teaching is called by Barone (2007) *Narrative Construction*: “Narrative construction is an approach to social research in which data are configured into

any of a variety of diachronic, or storied, formats" (p. 454). The characteristics of narrative construction are:

- The political dimension. The narrators will consciously or not display the power relationship that exists in their society, which can also be manifested by the dominant rules, myths and beliefs.
- The individual perspective. The stories can be considered fictional because their aim is not to represent events and happenings but the interpretation given by the narrator. Furthermore, for those events and happenings, the students will necessarily use their imagination to make the events and happenings coherent.
- The audience. The primarily audience of the story is the narrator-student. The student can understand the story and hopefully understand which changes need to be made in life. Is this a limitation from the audience perspective? No, colleagues, parents and society in general can read/hear the story. In this process, they can try to understand life through the eyes of the narrator-student and help the student in his/her analysis of life. Furthermore, in this process, colleagues, parents and society can relate the story to their own lives and decide to what extent the story is applicable to them.
- The outcomes. The previous characteristic of narrative construction is strongly linked to the issue of the outcomes that can be expected by using the Cultural Model of Teaching. My stand is that a single answer to this issue is not possible; hence, the Cultural Model of Teaching depends on students' agency to bring what is 'good' for them and for society into the classroom. The elusiveness of 'good' should not be an excuse to not have it as a goal of our science education.

> Good education research is a matter not only of sound procedures but also of beneficial aims and results; our ultimate aim as researchers and educators is to serve people's well-being. (Hostetler, 2005, p. 16)

- The media and modes of representation. The Cultural Model of Teaching does not give priority to any specific way of representation. Hence, the model has the potential of developing skills chosen by the narrator-student. The media selected by students depend on their imagination; it can be one or a combination of oral stories, theatre, film, video, dance, singing, music, photographs, sculpture and paintings.
- There are no elected narrators, so everyone can tell his/her story. How then can we judge if it is worthy? The main reference could be to exploit each story deeply and avoid repetition. There are many aspects in our life that need to be addressed. In this way, the Cultural Model of Teaching addresses the issue of giving a voice to students but does not pretend to replace other forms of logic such as World Modern Science, which can also appeal to students.

The Cultural Model of Teaching accepts narrative logic without questioning its origins, validity or trustworthiness. One of the most important contributions for students achieving multiscience education is to allow them to view their identities through stories that can vary according to the situation described and students' consciousness. I view this as students' cultural development.

Furthermore, the Cultural Model of Teaching contributes to the cultural development of community because this occurs parallel to individual development; therefore, personal development should also include other people. The attempt to develop ourselves should be done "not by excluding ourselves from others, but rather, by including others in our effort" (Golmohamad, 2004, p. 9). This is in accordance with the African perspective that community always comes first and we are inseparable from our community:

> … a vast, ever-expanding net of spiritual, psychological, biological and emotional relations. The African community shares the earth with the unborn, the living spirits of the dead, the earth, mountains and sky. (Venter, 2004, p. 2)

Stories are based many times on our everyday lives that according to indigenous-local knowledge depend also on spirituality (see Chapter Five).

Spirituality in science education

A Cultural Model of Teaching contributes to students achieving multiscience education because it promotes local-indigenous knowledge that is characterised by spirituality. I grew up at the end of the colonial era, which instilled in me the view that spirituality could be demonstrated only during a certain period of inspiration by literate people. Those moments of inspiration occurred when literate people produced cultural artefacts: poems, sculptures or thoughts. Looking back, the colonial discourse was incongruent because 'illiterate' people in Mozambique also produce and have been producing poems, sculptures and philosophy for centuries.

My people and I use cultural artefacts to express how we have been oppressed by the colonial power; how to conduct the rites involved when a person is born or dies in our society; how to face the struggles that we are facing in everyday life to survive; how not long ago to face the success or failure of many of us who went to South Africa looking for jobs in the mining industry; how to face our floods, droughts and disease. Perhaps if we were to view the producing of songs, dances, poems and other cultural artefacts as part of the solution to our problems, rather than as just expressions of doubt and despair then we can awaken in us a 'citizens agency' that strengthens our consciousness about our interests and identities. Multiscience education is the teaching of science that can awaken our agency as it can incorporate the usage of local-indigenous knowledge.

Including spirituality in science teaching can occur with the incorporation of local-indigenous knowledge, because local-indigenous knowledge incorporates both material and spiritual views of the world (Aikenhead, 1997; Golmohamad, 2004; Jane, 2003). This is also illustrated by the way that I have distinguished World Modern Science and local-indigenous knowledge in Chapter Five, based on (a) a car moving, (b) a student succeeding in school and (c) an athlete succeeding in a marathon. Inclusion of spirituality in science teaching has the

potential to fill the vacuum created by the teaching of World Modern Science alone (Kawagley, Norris-Tull, & Norris-Tulli, 1998).

Figure 6.6. Traditional healer.

Figure 6.7. Street boys.

Figure 6.8. Church.

Which spirit to include in science education?

At this stage of my research I was wondering which spirituality I would propose to be taught. Many Africans, including me, believe that our life runs smoothly when we are at peace with our ancestors. Effort pays off, luck falls your way, and troubles disappear in everyday life. This peace is reached by an annual ceremony of remembering the dead, called 'mhamba' (mass), in my ethnic group. I do not see myself teaching this to students; consequently I will not ask my student-teachers to do so. What if a family (represented by one student) has changed or has never believed in mhamba? If I am the teacher saying that mhamba exists then my beliefs could be taken as an imposition on that student. Since I would not talk about this spirituality what spirituality do I teach then?

I remember an episode that I had with a shaman. My house was burglarised and a friend recommended solving the issue through a shaman. I accepted because I could not replace the stolen things easily. After the initial rituals she told me that I had no problem. Soon I would make a journey that would go well. My uncle, who was with me, replied saying we were facing other problems. She could not figure out what the problem was. However, six months later, I was invited to visit the University of South Africa for three weeks. I also do not think that this is a good example to be included in the science classroom. However, I feel that spirituality should be included in the classroom. I am questioning how to teach and which spirituality to teach?

Today in the process of revising this Chapter I conclude that the standpoint that I have taken in this box reflects the positivist way in which I was enculturated in science education: to teach means that the student should reproduce what the teacher says. I still have a long way to go to shake off the yoke of the positivist view of the world that was inculcated in me.

The usefulness of World Modern Science is recognised worldwide. Did this 'usefulness' happen by chance or was it programmed? How can it be that people are dying of hunger and diseases such as malaria and AIDS while World Modern Science is so useful? An important factor that needs to be taken into account is that World Modern Science investigates things not determined by human needs alone. World Modern Science does not address fully human needs because of its limitations, which are related to the promotion and attainment of material wealth (Cobern & Loving, 2001).

My experience tells me that in the material world one is considered a human being according to his/her race, skin colour, place of birth and monetary wealth.

Another limitation of World Modern Science is the lack of focus on the relationships among human beings and between them and their environment. As a result, World Modern Science does not fulfil all the needs of human beings. For example, it is consensual that our world has become a global village through colonialism and technological developments that have brought computers, telephones, televisions and air planes. This has made it possible for Mozambicans to share our feelings despite our location in the world. Not long ago many of us were fortunate to share the emotion of seeing a Mozambican athlete, Lurdes Mutola, winning several medals, including 13 gold medals, around the world in cities such as Sydney (2000), Atlanta (1996), Paris (2003), and Toronto (1993). In these events World Modern Science can explain why we are able to see the images of our athlete but it does not explain how we feel, how we become united and why each of us becomes more connected with our ancestors. For this we need, as Afonso (2007) affirms, a philosophy of eco-justice and eco-pedagogy in science education that can be represented by the Cultural Model of Teaching that I am presenting here.

The limitations of World Modern Science reside in its genesis. In the beginning, World Modern Science divided the world into two domains: the material and spiritual worlds. The first fitted into science and the second into theology. Descartes (1596-1650), the mathematician and philosopher, claimed

that the world was created by God and was formed of two substances: matter and spirit. Matter was the physical world and the unique object of pure mathematics. Spirit was in the mind of human beings. The division of the world into matter and spirit still prevails and creates difficulties in thinking in an integrated way, in the ways we understand matter and spirit as connected (Semali & Kincheloe, 1999).

The fact that the material and spiritual worlds are connected is partially shown by science itself. Quantum physics and chaos theory postulate, for example, that the phenomenon depends on the observer. This is an argument to show, first, that science depends on people and hence is not value free; and, second, it is necessary to close the gap between the researcher and researched. One way of incorporating both the material and spiritual worlds is called 'participatory knowing' (Denton, 2005; Skolimowski, 1994). The participatory knower refuses a singular and objectified view of reality, and is concerned with constructing a coherent understanding of reality that refuses a separation between knower and known.

One component of this integrated self is spirituality which determines a specific ontology and epistemology. Participatory knowers respond according to the context and intention of education to questions such as: (a) what is important to include in the science classroom? (b) how do we analyse achievement? and (c) how do we apply the obtained knowledge?

The question raised by Jane (2003) is whether participatory knowing can be taught in schools? The answer to this question implies knowing beforehand a definition of spirituality. A coherent and consistently accepted definition of spirituality is difficult since spirituality is viewed as a personal position. Two reasons for this attitude of seeing spirituality as an individual matter are suggested to help understand what spirituality is and to explain World Modern Scientists' attitude towards spirituality (Aicken, 1991; Speck, 2005):

(1) *Separation of Church and State* – In Mozambique, as in many countries, the Church is separated from the State. Although intended to promote the freedom of citizens in relation to spiritual matters, this separation brings about dilemmas and uncertainties. Citizens representing the State are

fearful of presenting their beliefs to other citizens as this can be taken as imposition. This helps to explain why teachers do not include spirituality in their teaching and why spirituality is not seen as having a place in the science classroom. It is also not included in curricula that guide teachers' work.

(2) *Epistemology of* World Modern Science – The positivist epistemology in the science classroom hinders the inclusion of spirituality in classroom activities. According to this epistemology scientists' beliefs do not interfere and should not show in their work. The irony of this situation is the conception of an academic institution as an obstacle for exchanging ideas and points of view. This is understandable as spiritual inquiry contrasts with the world of World Modern Science. Spirituality is a "difficult territory of the invisible, unverifiable, and unreplicable" (Denton, 2005, p. 758).

According to Robinson (2005), spirituality can be seen as "activities which renew, lift up, comfort, heal and inspire ourselves and those with whom we interact". This definition shows that the dilemma that I faced when I decided to make the proposal to include spirituality in the science classroom was artificial. I was thinking that I would need to create something new to show that spirituality is there.

The definition tells me that spirituality is shown by the devotion of scientists to their work and not just to their results. Therefore, those who have been 'moved' by science show the 'spirit of science', just like those who have been 'moved' by soccer show the 'spirit of soccer'. Wei and Thomas (2005) use terms like 'scientific spirit' and 'spirit of creativity' to refer to what I have called the spirit of science. Coming back to Jane's (2003) question of whether spirituality can be taught in schools, my view is that if by 'taught' we actually mean to 'elicit' the spirit, then the answer is yes.

Spirit in the science classroom can be elicited through cultural activities. The activity that stimulates students' pleasure and dedication is the one that shows the spirit of the students. This means that spirit exists within the students and just

needs something to stimulate it. The process of eliciting spirituality, for me, is the formation of student identity that I advocate as part of multiscience teaching. Is there any supremacy between spirit and matter?

Spirit may impel students to make the decisions that they are making. Therefore, my understanding of the relationship between matter and spirit can be described by the same relationship between the two forces (action and reaction) described by the Newton's Third Law. Spirit exerts influence on matter at the same time as matter exerts influence on spirit.

A spirituality that, in general, is considered not to be linked to the material world needs to be included in the multiscience classroom according to two principles. The first principle, Non-Maleficence (Do Not Harm), also makes sure that students are not forced in any way to take a particular stand about what has been taught in the multiscience classroom. This principle addresses the concerns of educators about achieving 'good' outcomes through education. These good intentions may be problematic because of the meaning of 'good outcome'. Good for whom? In which context? At what cost? What are the other collateral results of this good? Similar questions and deeper discussion of achieving good outcomes through education are presented by Hostetler (2005).

I question to what extent are we following the principle of 'Do Not Harm' in the science classroom in Mozambique if students pass only if they demonstrate a certain level of achievement. Furthermore, I question how the teaching of World Modern Science can be considered as acculturation (see Glossary) if the students pass only when they demonstrate that they have mastered that science.

It seems that, in coercing students to achieve according to the standards that we have pre-defined, they do not have any choice other than to accept those standards as the primarily reference in their studies. This procedure does little to promote spirituality in science education; indeed according to Mackler (2005), a common mistake in science education is to separate life inside and outside of classroom, an approach which:

> (a) posits intellectual work and everyday life as enemies (or, at the very best, as strangers) by way of glorifying the former; (b) posits intellectual work and everyday life as enemies by way of glorifying the latter; or (c) posits intellectual work and everyday life as being in need of connection that can only come through the application of the former to the latter. None of these approaches is adequate, as each neglects to acknowledge the transactional connection between these two dimensions of human existence. (p. 1)

The second principle related to spirituality is 'There is No Correct Answer'. Students should not be obliged to take a definite stand on what is being taught. The main intention of including spirituality should be to promote learning and not to be an end in itself. In other words, each position taken should be investigated and not assumed to be good or bad. In this way, everyone can feel comfortable in discussing his/her spirituality (Denton, 2005; Gilley, 2005).

Figure 6.9. Spirituality connects the individual with his/her environment.

Spirituality in education keeps us moving forward and gives meaning to what we are doing. The meanings that can be offered by African spirituality can be found in the notions that characterise it: (a) harmony, (b) the sanctity of nature, (c) humans are the weakest part of nature, (d) humans are not in transit, and (e) God belongs to all humans. The meaning that we are making of our process of learning defines who we are (Gilley, 2005)

My readers may still wonder about the connection between spirituality and my Cultural Model of Teaching. A multiscience education would incorporate different epistemologies, ontologies and axiologies, and hence spirituality is just one way (equally limited) of explaining the world that a connected knower can apply to him/herself. Considering the distinction that I made in Chapter Five between World Modern Science and local-indigenous knowledge, a connected knower could ask him/herself: How true is the belief that there is only one cause

for each event that happens in our lives (given by World Modern Science)? How complete is the list of causes based on local-indigenous knowledge for each event that happens in our lives?

Implementation of Cultural Model of Teaching

My aim in this section is to reflect on how the Cultural Model of Teaching could be implemented in the science classroom. My stance in this research is that our realities in Mozambique vary from ethnic group to ethnic group and within each ethnic group the same situation is not perceived in the same way. How then can I propose an acceptable way to implement the Cultural Model of Teaching throughout the country? My response to this question is based on my perceptions of my childhood.

Figure 6.10. Our way of preparing food includes pounding peanuts.

A Cultural Model of Teaching can help in the formation of students' identity by emphasizing the process of learning. The process of learning is emphasized when students have opportunities to reflect critically on their own learning. In this process students answer from different perspectives and logics how applicable is what we have learnt from World Modern Science outside the classroom? This focus on applicability will not limit what to teach but will enable students to feel that World Modern Science is connected to their lives.

Other ways of focussing the process of learning can involve the students in (a) describing the practices that they know from their everyday lives, (b) investigating those practices in their contexts, and (c) analysing those practices using different views of the world. I use ways of cooking and dealing with water as an example to illustrate this process. Stories told by teachers and students (Goodson, 1995; Rex, Murnen, Hobbs, & McEachen, 2002) can be based on questions such as:

Q1. How do we traditionally prepare food and cook? – This question generates the need to know (to describe) various ways of cooking, including hunting, collecting, processing and preparation of food.

Q2. How does this traditional way of cooking reinforce the established norms of conduct in (y)our community? – This question leads to analysing and knowing the social relationships that we have in our communities.

The standpoints that students will take in relation to these issues will contribute to the formation of their identities. I have no evidence of anyone who is using this method in secondary education. My experience tells me that many students are left alone to apply what they are studying at school in their own local settings. They find themselves trying to apply a new discourse that is hardly well received as it ignores what already exists in that setting. Under these circumstances many students opt to play Fatima's Rules (see Chapter Five) and pass at school, while they are willing to learn after school how to live, work and do things.

Is there any advantage of the current method of teaching? Yes, especially for those who decide to have one-way border-crossing and do not experience any difficulty in the process (see the collateral theory of learning in the Glossary).

Q3. What can be done to improve our ways of cooking? – Students take standpoints according to their values and the values developed in the multiscience classroom.

Q4. How feasible for (y)our community, in the short and long term, is this way of cooking, in terms of cost, energy used and environmental sustainability? This question leads to an analysis of the phenomenon of 'ways of cooking' within the framework of World Modern Science.

Only question 4 is currently addressed in Mozambican schools, and only partially, while in multiscience education, students need to be involved also in addressing the first three questions; for example, by challenging the bias that cooking and all activities that involve pots, plates and water are activities for women only. Participation of women and men in any activity allows that the same activity can be analysed from different perspectives; that one gender cannot either abstain or control. This has the potential to improve social practices.

For water, similar questions can be formulated. I have seen in many places in Mozambique people gathering water from rivers and dams. They carry yellow plastic containers on their heads and immerse them in the water (Figure 6.11).

Figure 6.11. Village water collection.

Figure 6.12. Zambezi River where Cabora Bassa Dam is built.

Figure 6.13. 10 km away from Cabora Bassa Dam.

In the Cultural Model of Teaching these practices would be discussed in the science classroom seeking for an understanding of the practices and their likely transformation. Also related to water, during a certain part of the year (Figure 6.12), we have clean running water in the rivers, but in other periods of the year it is necessary to dig wells in the riverbed (Figure 6.13). In other places there is no well, riverbed or dam. In class we can discuss where and how people manage to find water throughout the year. Specific questions that could be addressed in the multiscience classroom towards the Mozambican problem of water and how I might answer those questions if I were a student are outlined below.

1. <u>How do we traditionally collect and preserve water?</u>

By ‘traditional’ I am referring to the ways used by people who do not have running water at home. Those traditional ways vary greatly from region to region because of the geological differences among those regions. In some regions, there are no rivers or dams, and the wells need to be so deep that advanced technology is required to dig them. Fortunately, this was not the case where my grandparents used to live in Ndavene.

I was able to participate in this activity in the early ‘70s. There was a well about 5km from our hut. It was necessary to go there as early as possible in the morning because it used to be crowded and it was not enjoyable to walk under the

strong sun, either in the winter or summer. We used a donkey to carry a barrel. In this way, we collected water for two or three days. The amount of water we brought home was augmented by other containers that we boys could carry in our hands or that women could carry in theirs. One type is the yellow container that can be seen in Figure 6.11.

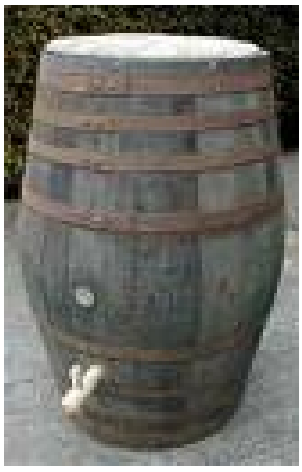


Figure 6.14. Barrel.

Figure 6.15. Donkey.

We used ropes called 'Ntsondzo' to tie the barrel to the donkey. For many of us, it was a challenging process to make the donkey obey our commands.

Figures 6.14 and 6.15 represent the donkey and barrel that we used to use to collect water

The barrel that I used leaked water in many places, adding other problems to the ones created by the donkey's behaviour. It was necessary to get home quickly and transfer the water to other containers. At home we preserved the water in a special container called 'mbita'.

2. <u>How does this way of collecting and preserving water reinforce the established norms of conduct in (y)our community?</u>

It seems to me that this activity of collecting and preserving water was, on the one hand, a product of existing norms of conduct and, on the other hand, a reinforcement of those norms. I cannot recall men being at the well. This indicates to me that in my ethnic group, water collecting activities were the responsibility of women and youth.

3. <u>What can be done to improve our ways of collecting and preserving water?</u>

In the multiscience classroom, the major contribution towards improvement can be in making students and, through them, the society aware of their situation and the challenges to be overcome. Why was the well so far away? Why didn't we use a metal barrel? (see Figure 6.16) Why were only women and children struggling with the donkey's behaviour? An interpretation of those questions can be that I am conveying that to have running water is the solution. Indeed this is my dream but there is a question of 'running water at what price?' In many cases the running water that we have in the cities is reserved in dams that cause serious ecological problems such as soil erosion, species extinction, spread of disease and changes to the Earth's rotation (Bednarek, 2001; Kondolf, 1997). So, to have running water is not necessarily a solution to the problems that I am facing. Nevertheless, it seems to me that my way of collecting water when I was at my grandparents' house offers multiple possibilities to teach 'movement', 'force', 'collaboration' and 'spirituality', among other concepts.

Figure 6.16. A metal barrel

4. <u>What are the physical, chemical and biological characteristics of water?</u>

This is the question that can incorporate the teaching of World Modern Science into the Cultural Model of Teaching. Here I am not focusing on World Modern Science and hence I am not expanding on my response to this question. Instead, I use this question to illustrate how the Cultural Model of Teaching can interconnect local-indigenous knowledge and World Modern Science. The teacher, in the process of analysing the story of collecting water, can ask (a) How can we collect water using several containers? (b) Can we enumerate the ways in which we are using water? Do we know how other people collect and use water? Those questions will elicit answers from local-indigenous knowledge and World Modern Science that should be equally accepted.

In all four questions the aim is not to determine what is necessarily right or wrong, but what exists, in order to help students to make informed decisions about their lives. I am aware of the large number (50 – 60) of students in science

classes at primary and secondary levels; however, this is a challenge and not a limitation. It is a challenge in the sense that the large numbers of students requires teacher imagination as well as the conviction to use a reflective style of teaching. This imagination and conviction should be cultivated during teacher education. At the moment, one of the major difficulties in the process of learning in Mozambique is the national examination which determines that, in ideal conditions, schools nationwide should teach the same content, deliver the same number and order of lessons, and use the same methods of delivery. This does not help to implement the Cultural Model of Teaching.

> If students are going to understand their relationship with the environment and with one another, they will need to understand the multiple dimensions of culture. But most teachers I have encountered reinforce in the classroom a culturally specific way of knowing that represents the rational process as individualistic and a correspondence view of language in which ideas stand for the external world of objects and events. (Bowers, 1993, p. 167)

My view is that this standardization is a major limitation to (a) contextualizing the teaching/learning process, (b) addressing students' needs and (c) including local-indigenous knowledge. I do agree with having a central science curriculum driving education in Mozambique. However, the curriculum should create space for local-indigenous curriculum adaptation that responds to the students' and communities' needs. The Cultural Model of Teaching that I am proposing here aims to include local-indigenous culture in the science classroom as a means for students to achieve multiscience education but not to simply worship their own local-indigenous culture that is also characterised by locally available materials and their use.

I have exposed how I have been using locally available materials in my teaching (Chapter Three). The process of teaching-learning by doing is viewed as appropriate for building skills and better understanding of the world surrounding the students (Aikenhead, 2000; Allsop, 1991; Cobern, 1998; Driver, Asoko, Leach, Mortimer, & Scott, 1994; Gunstone, 1991, 1995; Hodson, 1999; Murphy, 1991; Roth, 1998; Suskie, 2000; Tamir, 1991; Woolnough, 1991; Yager, 1991). In the

Cultural Model of Teaching I draw on my experience of including locally available materials to propose the use of this technique to promote multiscience education.

Techniques of achieving multiscience education can be designed according to personal and social constructivist theories of learning (see Chapter Three). These theories of learning can help students and teachers to generate the idea that science is the result of men and women dedicated to explaining their world.

Multiscience education is the driving force for including locally available material but at the same time constitutes the aim of using this material in the science classroom

The achievement of multiscience education in Mozambique will necessarily include strategies based on the Science Technology and Society (STS) movement but also having in mind the desire to go beyond promoting World Modern Science only (see Chapter Five). In the classroom, experiments involving everyday materials and local-indigenous knowledge can connect science, technology and society. The use of locally available materials is an attempt to connect the teaching-learning process with students' real lives.

For example, consider again the problem faced all over the country of accessing clean water for domestic use. If we decide that the Cultural Model of Teaching must help the community where the school is located about the water problem (as I have illustrated), students and teachers will learn Western and non-Western concepts about how to find, keep and improve the quality of water. Each student can contribute his/her own personal experience. The theoretical and practical aspects of this knowledge can be improved each year. In this way schools will not only be educating the youth but the broader community as well.

A similar kind of education to the one that I am proposing here is called 'citizenship education'. Citizenship education was introduced in England and Wales as a unit of study in 1990. The main challenge faced by 'citizenship education' was a lack of adequately prepared teachers; consequently, the application of teaching and assessment was inadequate. These difficulties were eventually overcome with teacher education and professional development

programs. The main areas of education for citizenship in which teachers required an up-grade were “knowledge and understanding, skills of enquiry and communication, and skills of participation and responsible action” (Davies, 2004, p. 1754). The situation in Mozambique is that a part of the teacher education that should be provided by government, teachers will need to educate themselves to be able to apply the Cultural Model of Teaching in an reflective way.

Figure 6.17. Cultural model of teaching intends to conciliate modern and traditional views of the world.

> A danger facing teachers who move into a critically reflective mode is that of being marginalized. In a hostile culture, critically reflective teachers can be labelled as subversive troublemakers whose raison d’être seems to be to make life as difficult and uncomfortable as possible for those around them. Their raising challenging questions can lose them friends, harm their careers, and turn them into institutional pariahs. (Brookfield, 1995, p. 235)

The question arises as to who should implement the Cultural Model of Teaching in Mozambique? This question can be answered at three levels:

- Content taught in the science classroom.
- Students’ learning process.
- Teachers’ professional development.

In this final part of my chapter I am reflecting briefly on teacher education to clarify my thoughts on how the development of the Cultural Model of Teaching should be carry on. Implementing the Cultural Model of Teaching is not simply a matter of adding new content or learning outcomes to the existing curriculum. It is a process of transforming the actual Mozambican science curriculum. My vision is that in the transformed curricula we would have much more than the existing separation of students, between those who succeed or fail to learn World Modern Science. Instead we would have students who learn World Modern Science in general, who learn World Modern Science in terms of facing issues of (for example) water, cooking and health in our community, who describe and envision

the solution of our problems by applying local-indigenous knowledge, and who combine the two systems of knowledge. I call the process of achieving the Cultural Model of Teaching 'democratising science education' as it seems to me that the aspirations of 'all' students, skills and abilities, predilections and socio-physical locations of schools will be attended to. How then can I enable teachers in terms of developing their understanding of and how to apply the Cultural Model of Teaching?

The problem is twofold. On the one hand, how can we educate the new generation of teachers in order for them to adopt this Cultural Model of Teaching and, on the other hand, how can we help existing teachers through professional development to embrace this Cultural Model of Teaching? It is my view that this professional development/education can be achieved if teachers are engaged in investigating how the characteristics of the Cultural Model of Teaching are suitable for them and their students in their particular context. My proposal is that instead of giving recipes to future or existing teachers we need to help them become artful curriculum inquirers on how to make more democratic science education in Mozambique.

Democratising science education in Mozambique

> Pragmatism is a fluid and evolving philosophy, not a rigid, formulaic way of thinking. It is uniquely designed to respond to an ever-changing and uncertain world. It is future oriented and looks to results, …(Henderson & Kesson, 2004, p. 26)

Among other philosophies, I envision the use of Pragmatism in the field of science and mathematics education in Mozambique. Pragmatic teaching is teaching that considers the socio-physical context of the school, bearing in mind that many of the students will not necessarily have a truly local background (i.e., ways of thinking and doing things such as cooking, collecting water and speaking), and the students will not necessarily stay in that locality once their schooling is completed. Pragmatism seems to be appropriate for supporting the multifaceted development needed in Mozambique as it places importance on human agency

(Henderson & Kesson, 2004). Pragmatism allows teachers to look at themselves and the students they are educating, having their society as a primary referent.

I am aware that Pragmatism has been criticized for its role in promoting scientism (not looking at other ways of knowing besides World Modern Science), ignoring women's rights, and attempting to be universal. However, it seems to me that in Mozambique we can implement a form of Pragmatism that is not oriented to scientism. We can give value to each student democratising (see in Glossary - Democracy) in this way our educational system.

This is possible in a form of 'Deep Democracy', as developed by Arnold Mindell (Siver, 2005). Deep Democracy is formed by an attitude and a principle. The attitude assumed is the acceptance of every opinion that exists amongst ourselves, inside classrooms, between ethnic groups and throughout Mozambique. The attitude taken here is not the suppression of minorities in favour of majorities that happens in classical democracy. The principle of Deep Democracy is that all voices are crucial (see Siver, 2005). Those voices that can tell the students' aspirations and allow participation in our country's life can be heard if a particular approach to searching for them and so determining what should be taught in the science classroom is adopted. In this approach, teachers themselves will learn how to participate in democratic curriculum practices.

There are many strategies that teachers can adopt to democratise their teaching process. I have begun to envision how teachers can be helped through teacher education programs (see Appendix A) to engage in artful curriculum development by adopting seven modes of curriculum inquiry proposed by Henderson and Kesson (2004). My first draft of how teacher education could incorporate my Cultural Model of Teaching is summarised in Appendix A; it constitutes one of the priorities of my future research as a reflective science teacher educator.

Summary of The Chapter

Multiscience education is the teaching of science in which World Modern Science is not necessarily the final aim, as is happening now in Mozambican schools. Multiscience education has the potential of benefiting individuals, World Modern Science, Mozambican society, and perhaps other nations. Different from World Modern Science, multiscience education does not only promote students who have the potential to continue to study science at more advanced levels but 'all' students in the system. My view of multiscience education can be understood as addressing the concern worldwide of teaching citizenship; the ultimate outcome of education is to enable students to become critically thinking citizens who know who they are as well as their rights and responsibilities.

A multiscience education can be achieved from learning World Modern Science and local-indigenous knowledge in a Cultural Model of Teaching and learning to reflect critically about different domains of practice. The significance of multiscience education is that it can help citizens to understand that, in Mozambique as in the rest of the world, in all interactions with the environment the entire community is involved.

In this chapter I have argued for the need to shift our educational aims towards a multiscience education. I have argued that the actual curricula used in Mozambique, which promotes a single epistemology of World Modern Science, constitutes a barrier for making science teaching relevant to everyday life in Mozambique.

The aim of multiscience education is to help students realise that (a) each culture within the various ethnic groups that exist in Mozambique experiences the influence of other cultures within and outside of Mozambique, and (b) the interaction among members of these ethnic groups is another source for that culture to evolve. Although we have terminated the colonial relationship, in one way or another the ex-colonized and the ex-colonizers are continuing to influence each other culturally. Achieving these aims depends on how well teachers are prepared to apply the Cultural Model of Teaching. I have illustrated in this chapter that a prescription is not possible for every teacher, student and school in

Mozambique and that the democratisation of our education can guide each of us to establish the desired curriculum.

Have I Achieved My Dreams?

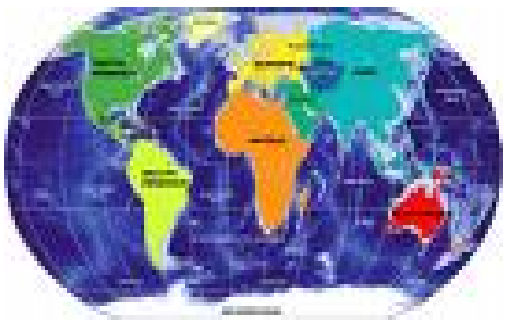
My research has finished or indeed has it just started?
What of the work of my mentor?!
What of the work of my colleagues?!
What of the work of my school?!
What of the work of researchers and lecturers?!
What of the work of those I know and others whom I do not know?!
Am I the one who has achieved my dreams?!

I present a rose to those who are connected to my work

Are there challenges still to be faced?
I was told that I needed a PhD to run undergraduate courses well!
I accepted that …
After five years of a PhD, I have some questions:

- Why is a PhD required to run undergraduate courses well?
- Am I going to transform all my students in the same way?
- Does the transformation only occur with doing a PhD, as I did?
- OOOOhhh! With a PhD, I have peace of mind because I know that I do not know what I know.
- There is no end to the research.

What challenges do I still have to face?



I invite you to face our challenges together.
I invite you to do a PhD, like me
You will know much about yourself:
How multifaceted you are:

- you are female, male, both
- you are child, adult, mature, all
- you are Black, White, Mulato, Yellow, all
- you are African, European, Asian, American, Australian, all
- you are indigenous, native, foreign, all
- you are scientists, producers of science, consumers of science, all
- you are educator, educated, both

Come and enjoy learning about yourself.

How about my loved ones?
Have I learnt about my wife Beatriz?
Have I learnt about my daughters Mariana, Ema, Helena, Veronica and Angela?
I have learned that my knowledge is incomplete without their contributions
How did my concept of family evolve during this study?
Have I noticed who has been taking care of me? (Black, White, Mulato …)
Are my colleagues part of my family?
Where are my lecturers situated?
Where is the support team of my school situated?
Where are my parents situated?
Where are my neighbours in Africa situated?

How does this relate to science?
I came here to develop my teaching skills
How is teaching reflected in this work?
Am I seeing the same challenges that I saw prior to my course?
Am I inviting others to know about themselves instead of the 'art' of teaching?
If I am talking about my loved ones …
You know! I have learnt that knowledge is power, and
I need to know whom to empower
Otherwise, I will keep disempowering myself by enabling those who I do not want to empower.

See you soon

A. Cupane
August 2007

My poem is a reflection on where we should aim for in the Mozambican education system. I use the poem first to look back and determine if I have achieved the goals (dreams) with which I started this research. One of my goals was to become a better teacher who is able to teach successfully World Modern

Science to Mozambicans with different cultural backgrounds. There is no single response to that issue and we (science teacher educators) need to join together to succeed in teaching World Modern Science without being colonizers or by betraying the colonized through rigid views of the world and science. Furthermore, with multiscience education in a cultural framework, as proposed, we can determine how to expand the narrow view of teaching and learning that is World Modern Science.

We need to talk the same language; hence, I am inviting my colleagues to reflect on their practices and to compare their conclusions with the ones described in this thesis (see Chapter Seven).

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Chapter Seven: Closing Reflections

Introduction

> It is possible to learn all the techniques of instruction but to remain pedagogically unfit as a teacher. The preparation of educators obviously includes much more than the teaching of knowledge and skills, more even than a professional ethical code or moral craft. To become a teacher includes something that cannot be taught formally: the most personal embodiment of a pedagogical thoughtfulness. (Manen, 1991, p. 9)

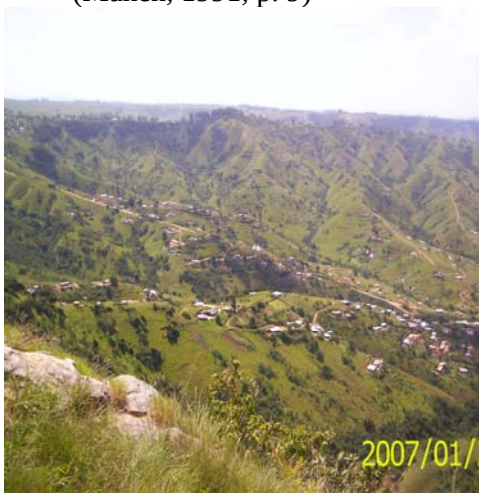

Figure 7.1. Valley of Thousand Hills.


Figure 7.2. Researchers and students.

Looking at where we live and teach, who are our students, and who we are teaching contributes to good teaching.

In this final chapter I reflect on and summarise my journey. I do not consider that my journey has ended, but I need to stop and reflect in order to be able to continue with it. My hope is that my reflections will waken other science educators so we can travel together in researching inclusive ways of seeing the world and teaching science.

I construct this chapter around the questions:

- What are the transformations that have occurred in me and potentially in my society?
- How do I perceive indigeneity at this stage of my research?
- How can my praxis benefit from the knowledge and values that I brought to this study as well as those I have developed during the process?
- What are my proposals for enriching this study?

Following these discussions, I reflect on the revelation that transformers of the education process should not look for a final form but seek to understand themselves as contributors to a never-ending process of improvement.

Transformation of the Researcher

What are the transformations that have occurred on me and consequently in my society? In this study I have used critical auto/ethnographic methods to help me better understand myself as an individual and professional. I started this research by looking for better ways of teaching, hoping that the research would enable me to teach physics better. At that stage I was conceptualising this innovative teaching as knowledge 'transmission' to students in Mozambique; furthermore, I wanted to be able to transmit this culturally enriched knowledge to every Mozambican.

But then I came to realise that in Mozambique the established way of teaching World Modern Science was imposed by Portuguese Colonialism. Colonizers used to refer to Mozambicans as ignorant and incapable of high order thinking or as black with a small 'b' (see Glossary). Paradoxically, with the excuse of 'moral obligation' the colonizers imposed World Modern Science in the same way that it was taught to the 'intelligent' colonialists' children. This showed that the colonizers believed in the universality of World Modern Science; in other words, that World Modern Science constituted a unique, valid and privileged way of thinking. My reflections synthesise how this research thesis negates this view. One of my aims was to inspire educators and teachers of World Modern Science to question the trustworthiness of the colonizers' view in Mozambique (Chapters Two and Three) and show how the experiences of other teachers in Mozambique resonate with my own.

I was also inspired by Palmer's (1998) reflections on his experience of teaching. He relates that not all aspects, moments or every activity in teaching constitute the 'pleasure' of teaching. I realise that (a) I was not the only one who experienced sometimes frustration with my teaching and (b) the causes of my frustrations did not necessarily lie with me or my students. I have also been

stymied by pretending that World Modern Science can be mastered by all my students in the same way.

> Then the enemy is everywhere: in those students from some alien planet, in that subject I thought I knew, and in the personal pathology that keeps me earning my living this way. What a fool I was to imagine that I had mastered this occult art – harder to divine than tea leaves and impossible for mortals to do even passably well! (p. 1)

This common aspect of my and Palmer's experience of teaching made me think that I could use some of the questions that he uses to contextualize his teaching. I selected the following of Palmer's (1998) questions to guide my work in this thesis: (what?) 'what subjects shall we teach?'; (how) 'what methods and techniques are required to teach well?'; (why?) 'for what purpose and to what ends do we teach?' and (who?) 'who is the self that teaches?'. Reflecting on these questions made me think that I had some competence in the 'what' and 'how' questions but little in the 'why' and 'who' questions. Therefore, to be a better teacher, it seemed to me that it could be worthwhile to concentrate on these questions. What I have found by looking at the 'who' and 'why' questions has allowed me to revise my understandings of the 'what' and 'how' questions.

The above questions ended up being included in my research and one of the most important findings was the identification of the methods to look at those questions. Critical auto/ethnography helped me expand the original research question from 'Who is the self that teaches?' to 'Who are my students?', 'What does it mean to be Mozambican?' and 'What does it mean to be indigenous?' Culture studies theories helped me to answer the research question, "Who am I?" This question basically incorporates all of the four previous questions.

Thus one of the main outcomes of this research is the development of my consciousness that my professional praxis should be shaped by my country, Mozambique, which is a multicultural country whose different cultures are so mixed that each of we Mozambicans can easily identify with at least two or three different ethnic groups.

Critical auto/ethnographic methods helped me understand the development of the values and attitudes in my life and profession, those values I brought to my postgraduate studies, those values I have reinforced or changed and those values I have developed during this research. The values that I brought to this research and those gained during these studies are mine but, because of the position expressed through the dialectical relationship we have with the world, these values also belong to my society (see Roth, 2005). Hence, if this study reflects my individual journey in life it also reflects the struggles that exist in Mozambican society and the rest of the world due to that dialectical relationship between us; in other words, we (I, Mozambicans and citizens from all over the world) have been influencing each other. This critical auto/ethnographic research has, therefore, regenerated my values and views especially in the field of science education.

The journey of building this understanding involved exploring with the tools of dialectical and critical thinking, together with theories of non/essentialism, non/dualism, postcolonialism, feminism, postmodernism and poststructuralism. These theories have informed me that I am an evolving creature; that I cannot remove the historic influences on my life but that I can be aware of those influences and make conscious decisions about serving the values I have gained by chance and the values I am building in my process of discovering who I am. Primarily, I am now aware that I should always be open to learning, because, even if my principles and philosophy are aimed at achieving equity for me, they do not necessarily have the same significance for everyone. By applying my principles and philosophy without discussion I too can become an oppressor and my principles and philosophy can become hegemonic forces.

This research has shown that auto/ethnography opens space for us to have a dialogue amongst ourselves, giving insights to improve our situation in general and the education system in particular.

I outline many of the challenges and benefits for those who will follow the path of auto/ethnography in their research. Indeed, it is a challenge just looking at yourself. For over 500 years, Mozambicans were told by colonizers what, how and why they should do even simple everyday things. Even worse, we learned that

by pleasing the colonizers we could alleviate our pain, and we did this in many ways. The liberation war (1964-1974), however, did not result in freedom of expression for any of us. In everyday struggles we see this constantly. For example, some doctors (or in many cases nurses) prescribe medicines without discussing their use and implications with us. Their argument is that the queue to be serviced is too long to spend 'unnecessary' time with each patient. The bus driver (private – there is not enough public transport) decides when to depart and when to arrive. At work, our superiors organise meetings to discuss what they have already decided. In this way, we continue to be systematically educated to be told what to do. Hence, the use of auto/ethnography by a Mozambican, where s/he has to disclose feelings, especially what we like or dislike and the significance of these things as an individual and a professional, can be very challenging and painful. Auto/ethnography has moved me into a very real 'discomfort zone'.

Figure 7.3. Auto/ethnography looks like a road in the mountains that can take you up and allow you to look down to where you came from.

The major benefits that the critical auto/ethnographic researcher can gain from this methodology are twofold. Firstly, it can be a process of catharsis. The researcher has the means to 'expel' what seems to have made him/her

uncomfortable forever, such as perception of skin colour or a given way of reasoning. S/he might discover that what they took for granted may not necessarily be so. The critical auto/ethnographic researcher, according to my experience, also can discover and grow his/her agency, realising that s/he is the one who has decided (a) to follow the influences that oppress her/him, (b) to assume a colonial identity and (c) to ignore his/her own culture. I have discovered my own agency while looking critically at the Mozambican education system. In this process, I came to question the extent to which I was influencing or could influence that system. The main constraint is that it may be difficult to start the process of catharsis and to continue that process to the final moment.

The outcomes generated by this critical auto/ethnographic research are influenced by an historical view of the world and my professional experience, both of which are incorporated in this study (Chapters Three, Four and Five). They do not, however, constitute a recipe for others. I am not in fact making recipes for myself, because what I have built is one understanding of my past and present (Chapter Three, Four and Five) in order to have an informed influence on my individual and professional future life (Chapter Six). This stance is reinforced by my experience which shows that in general there is a gap – sometimes a big gap - between what we expect and what we encounter. In other words, if this study produces narrow prescriptive recommendations this could be a source of frustration, because the situation that we understand today in Mozambique will not be exactly the same tomorrow. In this study, I have focused on developing my skills in critical reflexivity, using Mozambique as my subject. Hence, a major outcome is the transformation that occurred in me. The main transformation that occurred has been to my view of me as an individual and an educator and to my view of other Mozambicans and foreigners in Mozambique.

In relation to the original research questions ‘Who is the self that teaches?’ and ‘Who are those being taught?’, I have reached the conclusion that it does not make sense to talk about the ‘individual’ or the ‘professional’ in a dualistic sense (see Chapter Four) but I need to do so for the reader to understand which aspect of the ‘I’ I am referring to. Through this research I have found that I will never know categorically who I am, as I assume many identities in different situations.

Figure 7.4. My participants and I have been working in several schools in Mozambique.

One significant change in me is that I have, in the process of defining what my identity is, overcome the view inculcated by the colonizers that Africans are inferior to Europeans. These views are synthetised in the following poem entitled called *I Am the One Who I Am*.

I Am the One Who I Am

I was given a name to personalize my ancestors
I was colonized to build foreigners' wealth
I was taught science, Western science, to think as a Westerner
I am given back my freedom with the physical expulsion of the colonizers
I am told that I am the One who now determines events in my life

I am the One who has seen the dreams coming true
Is it true that colonizers who have been there for 500 years have vanished?
Is it true that my people and I won't fear any more the White skin?
Is it true that we won't have any more secret teaching?
Is it true that our traditions will flourish freely?

To what extent was I moulded by my parents, family, ethnic group, and society?
To what extent have I made myself?
I wouldn't like to betray my parents, family, ethnic group, and society
I wouldn't like to betray my conquered values
Who am I?

Figure 7.5. I have discovered myself through this research.

I am looking for myself within the city in which I live
I am looking for myself within the rural areas where my roots are
I am looking for myself within Western culture
I am looking for myself within my ethnic and African culture
I am looking but the images do not match who I think I am

I am thinking that all of these are constraints on my freedom
I would like to be a World citizen
I would like to be a freedom thinker
I would like to not be constrained by my tradition, colonizers, or Western science
I would like to be what I am

I fought for my freedom
I have used Western science to show its oppression of me
I have used my costumes and traditions to show their oppression of me
I am struggling to be enculturated in my own local-indigenous science
I am wondering if I will succeed in getting rid of Western science, local-indigenous costumes and traditions, and colonialism.
I would like to be what I am

My fight has evolved
I am also identified by colonialism, indigeneity, and Western science
I was never identified by mountains, panoramas, and emotions
I have languages and traditions that were never given value to be taught in school
I have evolved to have an integrated science in my classroom
I would like to teach who I am

How can I teach you without knowing who you think you are?
How can we create a better world without sharing the meaning of 'better'?
How can we describe to each of us who we think we are?
How can we accept discovering that we are wrong?
I think we are just Awareness/Emptiness
What do you think?

A. Cupane
Nov. 2006

My poem is both a product and an instrument of my inquiry. It shows me where I started my postgraduate studies and where I am now whilst seeking to evoke readers' knowledge of how they have faced the struggle of identity in their own lives.

What engages me in this poem is its ability to show how uncomfortable I was with myself when I began this thesis, and as this study developed I ended up accepting myself. The poem shows that I was focussing only on some aspects of my 'initial starting point' and now I see it in its complexity. I have said, for example, "I am also identified by colonialism, indigeneity, and Western science". At the beginning of my postgraduate studies, colonizers were only the 'others', indigeneity was a symbol of being oppressed and Western science was something that I could worship as the answer provider.

Now I am aware that these are all part of me; I am also part of the problem. My struggle now is to continue to transform or consolidate parts of the identities of me that I have just discovered. Being identified by colonialism is one of the identities that I do not want to wear. I am not saying that from now on I will not be identified by colonialism but instead that I am struggling to not be identified by colonialism. I am identified by colonialism when I refuse to acknowledge the existence of my own culture, language, science and a view of the world that is different from the Western view. I am identified by colonialism when I struggle to promote my ethnic group at the expense of other ethnic groups existing in Mozambique. I am identified by colonialism when I think that the Portuguese language that I speak belongs to Portuguese people while Mozambicans are creating it in our own mould with pronunciation, vocabulary and grammar that can hardly be understood by Portuguese people. I believe that to suppress this colonial identity does not serve my interests; hence, Mozambicans need to engage in a dialogue to understand which interests are being served and why. Unfortunately, we cannot do everything at the same time.

My final comment about this poem is that it has the characteristic of being an instrument of inquiry. The poem illustrates my belief that true inquiry goes beyond traditional interviews where the participants have fixed roles; that is,

asking questions and providing answers. In a postmodern interview these roles are not fixed. In my poem, although I am the one who is inquiring, I have started by telling my reader in an evocative manner how my identity was defined by various influences and how I now conceptualise my sense of identity. I end with a concise open question. This shows also how I see my thesis as a contribution to dialogue about education in Mozambique and the rest of the World.

Reconceptualising Local Indigenous Knowledge

How do I perceive indigeneity at this stage of my research? This section provides a summary of another main outcome of my inquiry which addressed the question: How can school science serve better the cultural development of local school communities in Mozambique?

The term 'indigenous' was used by colonial powers, mainly from Portugal, to segregate black Mozambicans (the small 'b' conveys a colonial meaning, see Glossary). Here the term is associated with the tragedies we, Mozambicans, went through during the colonial time. Today it does not make sense to use it, because those who are in power are native Mozambicans. On the other hand, 'local-indigenous knowledge' can be the knowledge that helps you to live where you are, and this meaning is widely accepted. This and the meaning of 'indigenous' in the dictionary (Hornby, 2000) support my claim that all of us are paradoxically local-indigenous. Local-indigenous or indigeneity is characterised by the place where we were born and our specific way of living, which are attributes that apply to everyone; hence, all of us are local-indigenous.

The 'why' question has had many metamorphoses in this research. It has always been clear to me that I learned science to improve my life. Consequently, my teaching should also contribute to improving my students' lives. Hence, the 'why' question becomes, 'Is my teaching of World Modern Science adequate to improve Mozambicans' lives?' This led to another question, 'What is improvement/development?' One finding is that my own and Mozambican interests can only be partially served by World Modern Science. The reason for this is twofold. First, World Modern Science is just one type of knowledge that exists in the world and it does not address my 'local-indigenous knowledge'.

Second, I was taught and I have been teaching World Modern Science as if it were universal knowledge and this requires me and my students to, therefore, ignore who we are. These findings arise from the discovery that I have my own science that should be incorporated into the science classroom.

On arriving at these understandings, the main focus of my thesis evolved to become 'What local-indigenous knowledge needs to be introduced into the Mozambican science classroom?', 'How to introduce local-indigenous knowledge into the Mozambican science classroom?' and 'What is the purpose of having local-indigenous knowledge in the science classroom?' These questions were addressed in Chapter Five where I argue that local-indigenous knowledge should be included in the science classroom without substituting it for World Modern Science. Furthermore, I am suggesting that Mozambicans should cease to see World Modern Science as a foreign science but to see it as one of the sciences available to them.

During this research, I found that Mozambican authorities are concerned about giving a Mozambican face to our education system. My understanding is that, like me, my fellow stakeholders are struggling to introduce local-indigenous knowledge into the Mozambican education system. It seems that the success of introducing local-indigenous knowledge relies on the recognition of the coexistence and interdependence of opposites (Basseches, 2005; Rowan, 2003). With respect to universal and local-indigenous knowledge, they coexist.

The main problem that we are facing in introducing local-indigenous knowledge is the degree of *comprador* (see Glossary) that exists in all of us, as Mozambicans, and the misinterpretations of what we mean by *local* and *indigenous*. I have suggested in this work the adoption of the 'local-indigenous' concept which solves problems such as:

(i) the definition of 'local' person and knowledge,

(ii) the relationship between that which is 'local' and World Modern Science, and

(iii) the interaction among cultures.

Figure 7.6. Indigenous knowledge includes our way of celebrating events.

The definition of ‘local’ is not without problems because it requires criteria that can include place of birth, colour and language, which are segregating concepts, not integrating ones. The relationship between ‘local’ person and ‘local’ knowledge and World Modern Science in context is a problem because World Modern Science alone is recognised in the science classroom. If our option is to include ‘local’ knowledge this will perpetuate the current situation of viewing World Modern Science as imported knowledge. This is disturbing since World Modern Science is the result of the contribution of all human races and, consequently, belongs to Mozambicans as well. The term ‘local-knowledge’ solves the problem of categorizing knowledge by offering the same status to all knowledge. Local-knowledge allows the interaction of cultures without stigmatization. It accepts the knowledge and experience of the knower without questioning where either the knowledge or the experience comes from.

Towards the end of my research I came across a paper entitled ‘Indigenous knowledge and science revisited’ by Aikenhead and Ogawa (2007). I read the paper keen to see if the authors had found the same problems that I have with the concept ‘indigenous’. One of these problems for me is that the term has not stayed true to my own interpretation of local-indigenous knowledge. This intention is betrayed when the term ‘indigenous’ is used to segregate one group from another.

I simply do not understand when non-local-indigenous people try to develop my local-indigenous knowledge, while considering that that knowledge is not knowledge or is just knowledge for me. Indeed, what I understand is that non-local-indigenous people can come into my world but I am not allowed to go into theirs.

By viewing differentiation as synonymous with indigeneity, segregation is not an issue. In my view, all of us are local-indigenous. We have developed differently and have different skills in communication, social relationships, arts and technology, skills that we need to share. Therefore all of us are in the same dimension which is the 'human being dimension' and cooperation bears fruit under the perspective of two-way border crossing (Aikenhead, 2001; Giroux, 1993) worldwide.

The quote below from Aikenhead and Ogawa (2007) indicated to me that we have a similar view on the issue of indigeneity.

> These two labels [local-indigenous knowledge and science] belie the great diversity found within each category and mask similarities the two categories share, for example, empiricism, rationality, and dynamic evolution. We recognize that the literature is replete with comparisons between Indigenous knowledge and science, but our project here does not continue the false dichotomy, Indigenous knowledge versus science, found in colonial discourse with its subtext of winners and losers. (p. 1)

Interestingly, our approach differs in the solutions proposed to promote local-indigenous knowledge. Aikenhead and Ogawa (2007) offer three concepts: *indigenous* ways of living in nature, neo-*indigenous* ways of knowing nature and Eurocentric sciences; whereas I propose two views: World Modern Science and local-indigenous knowledge. It was important to engage with Aikenhead and Ogawa's (2007) paper at this stage, as it illustrates how analysing the same phenomena can lead to different conclusions.

Envisioning a Cultural Model of Teaching

How can my praxis benefit from the knowledge and values that I brought to this study as well as those I have developed during the process? In Chapter Six I have developed a Cultural Model of Teaching as a way of making science teaching relevant to everyday life in Mozambique. It proposes a way of enabling students to live in harmony with themselves, the environment and others. The goals that can be achieved through this Cultural Model of Teaching depend on a non/essentialistic view of identity. All human beings should find their way of living, express their feelings and respect others at the same time (see Chapter Four). My view is that respect for ourselves and others is promoted when we know more about ourselves and about others. The Cultural Model of Teaching that I am proposing here encourages growth of self awareness and knowledge about others through the use of stories. Stories can help to activate students' science/life agency when they reflect on 'how could they modify the events in their stories?' The strongest advantage of the use of stories is that they are based on students' lives. This is an indication that students' stories can include their use of everyday material.

My Cultural Model of Teaching opposes the view that our life is determined by the material world only. According to this view we have to discover the general laws governing the material world and our duty is to adapt ourselves to that material world. My Cultural Model of Teaching implies also that this view should not be thrown away but transformed to the view that we human beings and the material world constitute part of the same reality and each of these two parts influences the existence of and transformations that occur to each other.

For the Cultural Model of Teaching the interests of those involved in science education are also served by the spirituality involved in that process. Spirituality can be understood as that which enables each of us to be at peace with our selves and the environment and, at the same time, to question our conditions and to move us to improve those conditions.

Spirituality can be understood at both individual and collective levels. At the individual level, spirituality makes the person stronger and thus more able to

Spirituality can be responsible for some of our attitudes and some of our attitudes can reinforce and develop our spirituality. The fact that spirituality does not influence all of our attitudes and vice versa makes difficult the perception of spirituality

face difficulties and obstacles. It is also because of our spirituality that we develop our skills in different ways, such as those of a mechanic, a nurse, a teacher or a priest. At the collective level, spirituality can be responsible for creating an environment in which each participant feels encouraged to belong, to participate and to develop the skills or abilities that s/he wants to.

Perspectives to Enrich this Study

My initial intention was to emancipate myself and my culture; today I realise that I have shown that in order to understand the whole society we need to understand its parts (individuals). None of them can exist by themselves (dialectical relationships). Emancipation means to choose your own constraints in life.

What are my proposals for enriching this study? I believe that through this research I have richly explored the aspects of learning and teaching science in Mozambique. However, I have done this from the perspective of an individual as illustrated by the poem 'I Am the One Who I Am'.

I have concentrated on my culture, on different understandings of local-indigenous knowledge, and on the experiences of learning and teaching science that support teaching through a Cultural Model of Teaching in science education, where World Modern Science is just one epistemology that exists in the world. My belief is based on my experiences as a learner, a teacher and an educator of science teachers, where I deeply interact with many colleagues from different ethnic groups, races and places inside and outside of Mozambique.

I am proposing in this thesis that individuals need to refuse to be defined by one essentialistic identity and instead adopt a strategic essential identity. The latter is mutable according to the needs and aims of the owner, while the former is always the same and, consequently, unchangeable even with the education process. By accepting that a Mozambican essence has no inherent existence, as I have discussed in Chapter Four, science teachers may be able to avoid a mechanistic

view of teaching and instead treat students as culturally embedded individuals, according to their needs and what characterises them.

Figure 7.7. Identity is not fixed.

Future research could explore the extent of differences in learning among the various ethnic groups of Mozambique. In this research I am suggesting that we are all human beings and many of our differences result from manipulation driven by a political agenda. Can we reach the same conclusion if we look to human beings using their different cultural knowledges and languages? Does the aspiration for a universal language make sense?

In the future I would like also to understand the nature of our mixture of ethnic groups in Mozambique. Our ethnic groups are creating a nation that can be characterized by a *third space* (Bhabha, 1994) having as a vector the concept of *border-crossing* (Aikenhead, 1997). At the moment, I think Mozambican society allows border-crossing among different ethnic groups in both directions, back and forward. This is explained by different theories that I have used in this study which argue that individuals can choose their own ways of living.

In this thesis I have not focused specifically on human cognition, individual differences, reading and writing capacities, giftedness, various types of learning difficulties, types of assessment or classroom management, but I do try to show why, how and which goals should be aimed for.

All types of study are needed in the field of education in Mozambique. This can be seen as enrichment for my study; for example, the role played by gender, class and ethnic identity in the science classroom are of interest. This study is limited in the same way that all studies are limited. Hence, this thesis is an invitation for you, my reader, and me to join in an effort to include our respective cultures in science education.

I would like to include in my future research designing an integrated curriculum (Ogunniyi, 2007) for Mozambique. I am what I am, also as a product of my formal education.

> Education is the great engine of personal development. It is through education that the daughter of a peasant can become a doctor, that the son of a mineworker can become the head of the mine, that a child of farm workers can become the president of a great nation. It is what we make out of what we have, not what we are given, that separates one person from another (Mandela, 1994, p. 194).

In my future research I will contribute with my responses to questions such as 'What should and should not be taught in science classrooms in Mozambique?' 'Who should decide?' My responses will be informed by this research which indicates the need to include in the science classroom (a) promotion of national unity, (b) promotion of intra and inter-tribal knowledges, and (c) promotion of local-indigenous cultures.

A supporting 'echo' of my conclusion and plans, affirming the non-narcissist characteristic of this thesis research and possible subsequent studies (at first glance), is given by Brickhouse and Kittleson (2006) who argue that:

> Science is best understood as a diverse array of local, discursive, and material practices. Although science is often described as a universal practice that transcends culture and provides value-free knowledge, scholarship in the cultural studies of science has described the ways in which scientific practices are dependent on local cultural and material resources. For example, the Scientific Revolution in Western Europe made use of cultural ideas of progress that had the effect of linking

> scientific practices with the Industrial Revolution and its desire to increase productivity and profit. (p. 191)

My attention was captured by the link that the authors make between local culture, local materials and local cultural ideas and science. I see this 'science' as being one of the possible science**s** on the Earth but the lack of an 's' in the quote indicates that the authors are referring to just one science – World Modern Science!

In my further analysis of the Brickhouse and Kittleson (2006) quote there emerged our difference(s) in teaching science. Apparently they maintain that World Modern Science should be taught according to where the school is located. This standpoint, for me, is supported by the view that all different activities around the Earth are ruled by World Modern Science. However, the anxiety experienced by many of us in science classrooms in Mozambican schools (see Chapter Four and Afonso, 2007) is sufficient proof that many of us in Mozambique experience different worlds at home and at school. Hence, my stand is that beside World Modern Science there should also be taught other sciences and expertises available locally that are called 'local-indigenous knowledge'.

Nevertheless, the quote made my wish stronger to pursue the research of connecting everyday materials used around the schools with the teaching in the schools. By bringing those activities inside the classroom my aim is twofold: (a) to help the teaching of World Modern Science and (b) to reveal other ways of thinking behind those activities. In Mozambique we are lucky to have a guru who is identifying the thinking behind everyday activities – Paulus Gerdes – however, my interpretation is that Gerdes (1994; 1998; 2003) is subordinating local-indigenous thinking to World Modern Science. I have questioned the assumption that World Modern Science is the only logic encompassed in Mozambican everyday activities (see Chapter Three).

My belief is that by making explicit the different logics that exist within our society we will be able to better face the environmental destruction made for profit by World Modern Science and promote eco-justice, eco-pedagogy and spirituality in science education. This combination of different epistemologies

could help students to be in harmony with themselves and their environment through our science education. The different forms of this harmony could be achieved with the help of the seven modes of curriculum inquiry outlined in Appendix A.

My view of the seven modes of inquiry is that they allow teachers and students to use feminist, postcolonialist, poststructuralist and postmodernist theories within different epistemologies. These constitute a contribution to the "emancipation of oppressed individuals and groups from normalizing metanarratives that effectively constrain alternative visions of the future" (Brickhouse & Kittleson, 2006, p. 195).

In Closing

I am closing this thesis by telling you that I have undertaken a journey of self-realisation in my research. What is unique in my achievement is the awareness of the complexity that constitutes our identity, the science education process in Mozambique, and the (in)visible culture that underpins our decisions in the field of science education. This thesis has enabled me to leave my research in a third space (a confluence of cultures, religions and sciences) as a connected knower; I understand you through your own values without throwing away mine. Connected knowers see each of us as unique cultural artefacts that cannot be replaced.

Figure 7.8. This thesis has transformed me and made me grow. I say ‘bye-bye’ hoping that this research can be a switch for the transformation and growth of my fellow science education practitioners in order to truly educate the children of Mozambique.

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